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BETON TUNNELS AND ARCHES.

THE question as to the best material for lining arches is a very important one.

The use of stone is virtually prohibited by the cost of cutting it into proper shape, and the blocks must be small, as no derricks can be used, and the working room is very small.

Wood rapidly decays in such situations, and recourse is naturally had to bricks.

We give, as a solution of this difficulty, the case of the Bergen tunnel on the Erie Railway, in Jersey City, shown in Fig. 1. This tunnel when built, was in those portions where the rock was likely to fall, or where there was a quantity of water working through the seams of the rock lined with brick. The brick arch was about two feet and a half thick and thoroughly laid in cement. The tunnel was made for a broad gauge double track. The brick arch effectually prevented the falling of any rock; but surface water from eighty to one hundred feet above worked down through the fissures in the rock and formed on it an enormous hydrostatic pressure, which forced the water through the brick arch. In summer this water falling on the trains was simply an annoyance, but in winter it became a matter of great cost and danger. The water percolating through the brick became frozen, and but for gangs of men going through the tunnel on cars constructed for the purpose and cutting away the ice the tunnel would have been blocked with one enormous icicle. In cutting down the icicles they brought with them portions of the brick work, which rendered the arch less secure.

FIG. 1.—BETON LINED TUNNEL.—ERIE RAILWAY.

It was decided by the railway company to reline portions of the arch that had previously been bricked, and to extend the lining with beton, and a contract was accordingly made with Mr. John C. Goodridge, Jr., President of the N. Y. Stone Contracting Co., of Third Avenue, corner Sixth Street, Brooklyn, N. Y., to do the work by the method invented by him.

This was accordingly done in the years 1876, 1877, and 1878, and we are informed it is a perfect success.

The arch as made was from four to twelve inches in thickness, and its appearance is well shown in our illustration.

This material is practically impervious to water. By fitting closely to the rock and the fissures in it there is only the hydrostatic pressure on the area of the fissure and not on the whole area of the arch. The lining can be made much lighter of beton than of brick arch, and being a monolith is much stronger.

An additional advantage, which diminishes the cost, is that the rock in the arch need not be cut so as to allow an arch of equal thickness as a ring of brickwork would require, but the beton attaches itself to and becomes a portion of the projecting rock. In the work above described over 300 trains were going through the tunnel every 24 hours, and the contractors could have but one of the tracks at a time, and then only between ten at night and four o'clock the next morning. During a large portion of these hours the tunnel was so filled with gas and smoke as to render work impossible and existence difficult.

When the work stopped for the day traffic everything that would impede the progress of trains had to be removed and the tunnel left entirely unobstructed.

Figures 2, 3, 4, and 5, show better than a description certain arches on the Buffalo division of the Erie Railway, all of which was done by same method — Fig. 2, done in 1875; Figures 3 and 4 in 1878. An arch under a heavy fill can in this way be repaired and made stronger than a new one at one-tenth the cost.

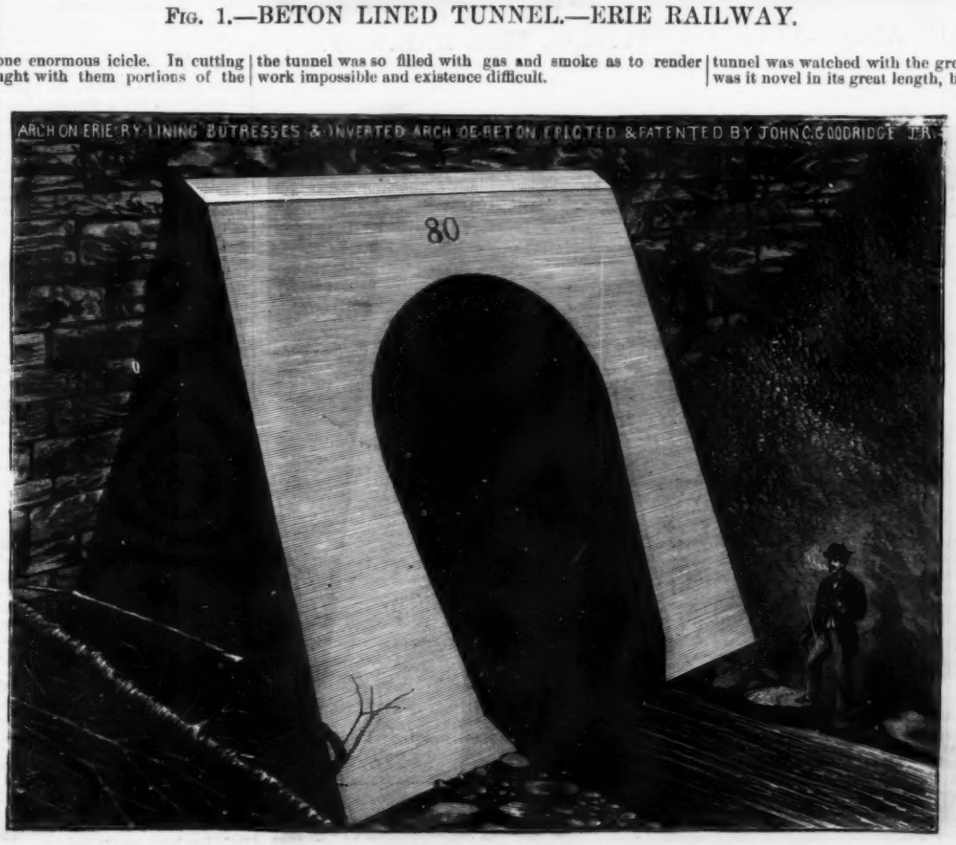


FIG. 3.—BETON ARCH.—BUFFALO DIVISION, ERIE RAILWAY.

THE ST. GOTHARD TUNNEL.

FOR the second time the human pholadean has perforated the Alps. The first hole through the great stone wall, the Mont Cenis Tunnel, was commenced in August, 1857, and the advance headings met on Christmas Day, 1870, the Mont Cenis Railway being opened in September, 1871. The time occupied by Grattoni and Sommeiller and their collaborateurs in piercing the mountain was thus nearly thirteen and a half years; but as the enlargement works, though kept well up with the heading, and making the railway, occupied eight months more, the work occupied altogether fourteen years and five months. The Mont Cenis Tunnel unites the French railway system with that of Italy, and has become the great high road to the East for all Western and most European travelers. The tunnel extends between Modane and Bardonecchio, and is thus confined to French and Italian Territory. It is 12,224 meters, or 7·57 miles in length. The construction of this tunnel was watched with the greatest interest, for not only was it novel in its great length, but the difficulties that were likely to be met with were considered almost insurmountable, especially by those who are fond of predicting against new departures in works of great magnitude. The hardness of the rocks, much of these being serpentine, quartz, and schistose granite, made the work one of great difficulty, especially as its novelty demanded boring tools which had even to be invented, and a mode of application of motive power which had been little employed, namely, the use of compressed air for tunneling work, as proposed by Giovanni Piatti. After various hindrances and difficulties, however, the work was completed in 1871, and in itself affords a grand monument to the skill of Signors Sommeiller, Grandis, and Grattoni. A remarkable monument of characteristic design by Belli has, moreover, been erected in Turin to commemorate the piercing of the mountain, the proposal being due to Count Marello de Panissero. The monument is 65 feet in height, and 25 feet in diameter at the base, which consists of piled-up rocks of large size, with seven Titans at different parts ostensibly grappling with and supporting the pile. At the top floats a Genius pointing to a slab at its feet, on which are inscribed the names above mentioned.

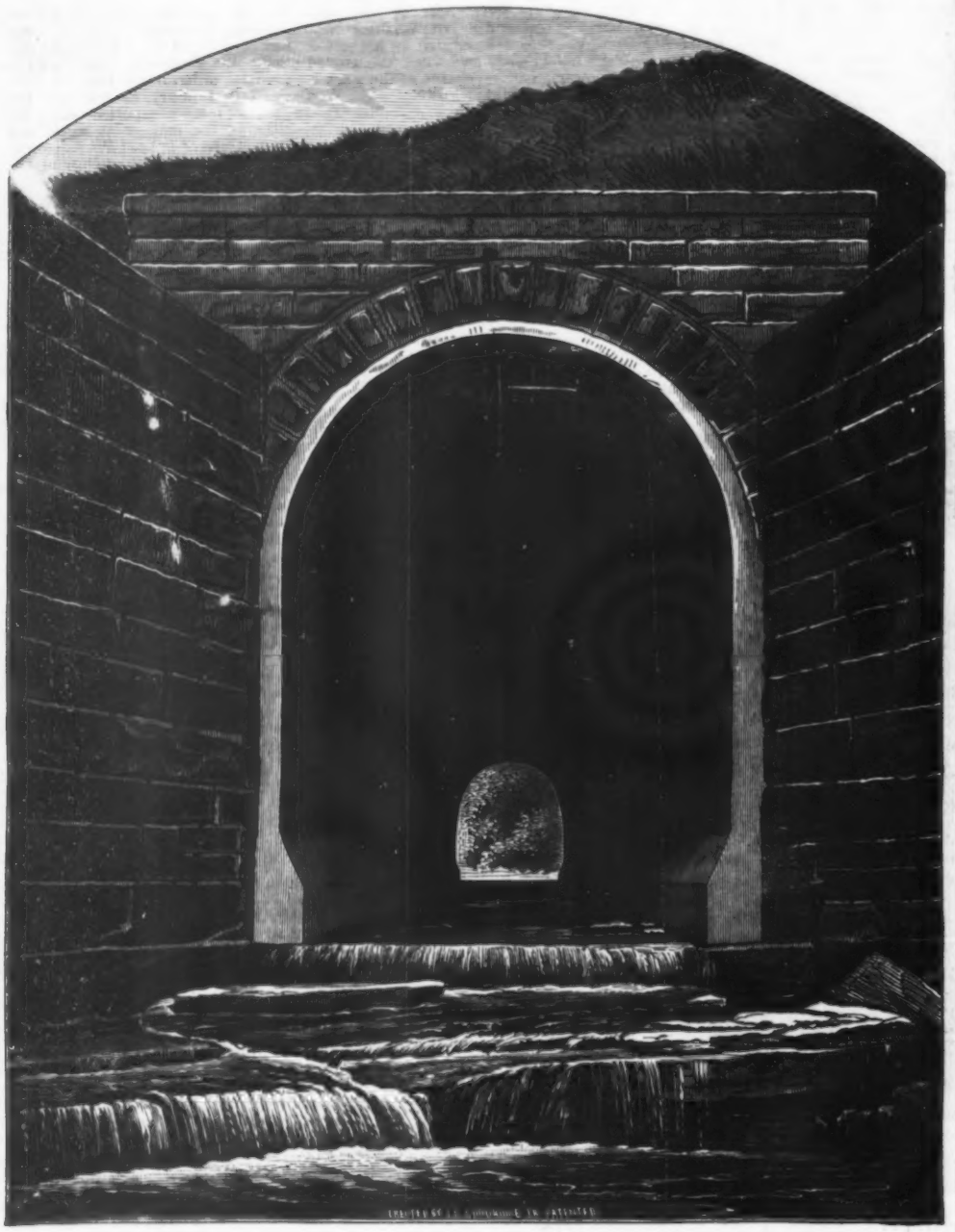


FIG. 2.—BETON ARCH.—BUFFALO DIVISION, ERIE RAILWAY.

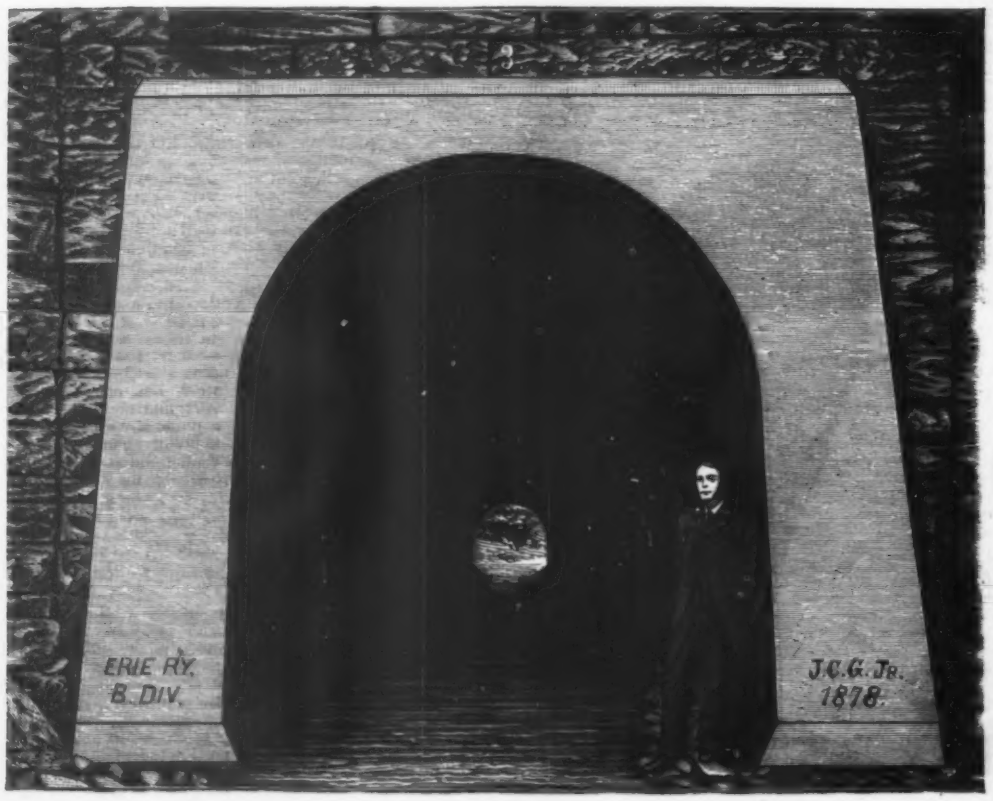


FIG. 4.—BETON ARCH ON ERIE RAILWAY.

After the successful completion of this work, it was not to be supposed that much time would be allowed to elapse before Germany, Switzerland, and Italy would see the necessity of connecting the railway system of Italy directly with the more northern parts of Europe without going into French territory. The St. Gothard Railway Company was formed in 1871. This was more correctly an international association, with £4,080,000 as capital, one-third of the capital being raised by each nation—Germany, Italy, and Switzerland. The company thus constituted was finally formed in Dec., 1871, and in the spring of 1872 the great engineering contractors of Europe were invited by the company to tender for the construction of a tunnel through the Alps between Göschenen and Airolo, the primary surveys having already been made by M. O. Gelpke, C.E., who set out the line of the tunnel, a work of great difficulty, owing to the necessity of employing fifteen stations, some of which were only accessible with great trouble. In reply to the invitation for tenders, M. Louis Favre, of Geneva—who was known in Switzerland and France as an able railway engineer, and as the contractor who executed the important works, including long tunnels, on the Lyons and Geneva Railway—sent in a tender which proved to be the lowest. The total amount of his tender, including all the works, and lining the tunnel with masonry, was about £2,000,000, or £136 per meter run. The lowest of the other tenders, of which there were seven, was from the Italian Public Works Company for about two and a-half millions sterling; and whereas M. Favre only required eight years to complete the work, the other required nine. For the guarantee of his engagement M. Louis Favre furnished as caution money £320,000. At the end of the eighth year, if the work is not completed, a sum of £200 will be drawn from the caution money per day during the first six months. At the end of this time the penalty will be £400 per day, and all the caution money will be forfeited if the work is not completed at the end of the ninth year. The Italian company would only forfeit the caution money at the end of the eleventh year. The contract was signed on the 7th of August, 1872, and approved by the Federal Council on the 23d of the same month. Many obstacles prevented M. Favre from beginning the work at once. The approaches to the tunnel heads, which were to be made by the company, were not completed, and he could not commence his operations. Moreover, the opposition of the Italian Government, demanding that half the works were to be granted to the Italian engineers who had made the Mont Cenis Tunnel, caused delay. M. Favre had much trouble upon this question, and negotiations lasted more than two months, and the time for making the St. Gothard Tunnel is to be reckoned from the middle of November, 1872, when the work was really commenced. The length of the tunnel is 14,920 meters, or 9·25 miles. The dimensions of the tunnel are nearly identical with those of the Mont Cenis Tunnel. The height to the crown of the arch is 6 meters, or 19·68 feet; maximum width, 8 meters, or 26·24 feet; and minimum width, 24·93 feet. Various systems of construction are adopted according to the nature of the ground. We now reproduce the sections for the convenience of our readers.

The highest part of the tunnel is 3,781 feet above sea level. M. Favre commenced working with Dubois and Francois rock drills, which were simpler than those of Sommeiller, by compressed air supplied by steam engines; but he afterwards employed McKean's rock drills, and turbines to work the air compressors. The turbines were obtained from Messrs. Escher, Wyss & Co., of Zurich, three being placed at the Göschenen end, and worked by water from the river Reiss under a head of 279 feet. At the Airolo end of the tunnel three other turbines were placed, worked by water from the Tremola under a head of 541 feet. Compressors made from the design of Professor Colladon are employed, each capable of supplying about 700 cubic feet of air per minute, at a pressure of 8 atmospheres. During the course of the work it has been found that the water supply from the Tremola was insufficient, and M. Favre had to bring water in an aqueduct 3,000 meters in length from the Tessin to work new turbines and for new compressors.

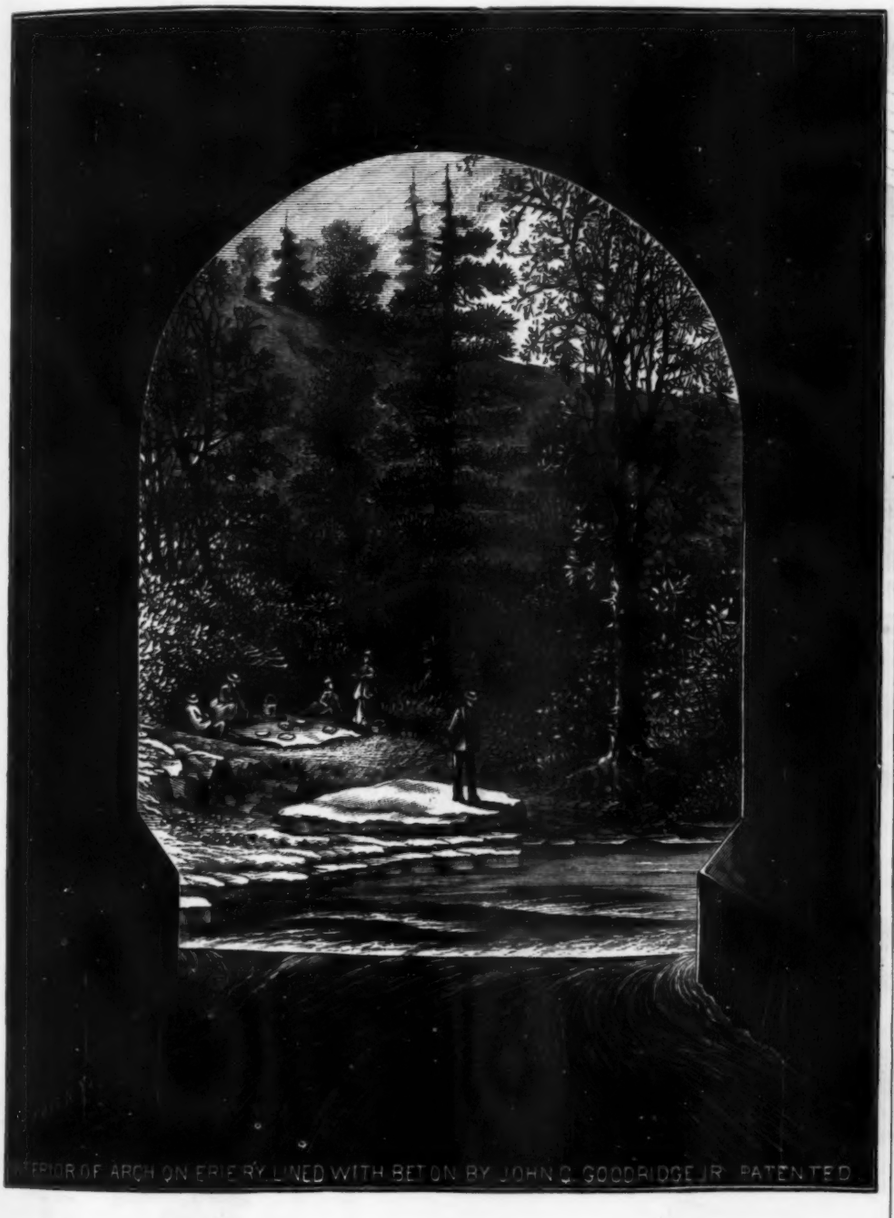
This was about twelve months since; the new turbines were of cast iron, and when these were put in it was noticed that the older turbines, the wheels of which were in bronze in one piece, were, after making 155 million revolutions per annum for five years, in excellent order, and only required their adjustments, for which means were provided. Sixteen compressors were employed at each end of the tunnel supplying air for working from eighteen to twenty rock drills and for ventilation. Other compressors were employed to supply the compressed air locomotives with air at twelve atmospheres for removing the *débris* to the mouth of the tunnel. For removing the *débris* from the inner part of the workings to those parts served by the locomotive, horses have been employed, and as the temperature within the tunnel has been about 100° Fah. it has been very deadly work for the horses, ten per month dying, on an average, out of a stud of forty. The rock consists chiefly of a hard granitic gneiss, much fissured, generally free from water; but some trouble was experienced in this respect a few months ago. At the Airolo end, gravel, sand, and pebbles were first met with; gypsum, talc, and mica schist were also found, succeeded by a dolomite. At about 286 feet from the end, a bed of schist was pierced, which discharged torrents of water; after this was passed granitic gneiss was entered. Some serpentine and other very hard beds have been met with, but that which has given as much trouble as any is probably the stratum of plastic material described before the Académie des Sciences by M. Colladon, on the 12th of January last. This stratum materially impeded the progress of the works about four months since, as it transmitted the pressure of the superincumbent or adjacent material to the centering, and so great was this semi-fluid pressure that the very heavy granite voussoirs of the tunnel lining were frequently crushed. The McKean rock drills are capable of drilling as many as twenty-six holes four feet deep in a face about six feet six inches square. The holes having been charged with dynamite, and properly tamped, about two and a half cubic meters have generally been dislodged. The progress of the boring has for some time been at the rate of from twenty feet to 24·7 feet per day.

In speaking of the progress of this work, it has been common with our daily contemporaries to speak of the recent completion of the tunnel. It may therefore be as well to remind some of our readers that, though the tunnel may be finished, including lining, for the greater part of its length, that part at which the miners have just met from the two opposite ends is only the usual advance heading. The meeting of the miners took place at 11.15 on Sunday morning last. Thus in 7¼ years this tunnel, considerably longer than Mont Cenis, which occupied 13¼ years in construction, has been nearly finished. The completion of the work, now that the two headings are united and a free supply of air established, will be comparatively rapid. The tunnel is

expected to be ready for traffic by the end of September, and the entire system of which it is the center in the summer of 1882. This great work, although it has so successfully ended in victory, has cost the lives of between sixty and seventy men, who have been killed by the premature explosion of mines and other mishaps; many more have been seriously injured, and those who have borne the heat and burden of the day are well worthy of the medals that were bestowed upon them and the *fête* with which they were honored on Wednesday at Airolo, and at which the Federal Council and the Governments of Germany and Italy were represented. The medal was struck at Genova, and is highly spoken of as a work of art. It bears on one side the arms of Germania, Helvetia, and Italia, with the words "*Viribus unitis*," and on the obverse, in German and Italian, "To the men of the Gothard Tunnel."

The death of M. Louis Favre in July last was an event which was scarcely more sorrowfully felt when it took place in the tunnel during his usual visit of inspection, than it was last Wednesday. To M. Favre much more is due than the great work of the construction of the tunnel. The work has had a checkered history. More than once the St. Gothard Railway has met with financial difficulties which have had the appearance of adding the whole enterprise to the list of unfinished projects known as follies. On one important part of the line, while M. Favre was proceeding steadily and energetically with the tunnel, it was found early in 1877 that the engineers of the railway had made a tremendous blunder in the estimates amounting to something like £4,000,000, and the railway work was therefore necessarily for a time suspended. Subsequently the payments to M. Favre became irregular, and difficulties seemed purposely thrown in his way. Favre's energy, zeal, and determination, however, overcame them, and those who would have caused a rupture between him and the International Society were foiled. In many ways the successful termination so far of the main part of the St. Gothard Railway works is due to M. Favre. The accuracy of his estimates and calculations have been singularly proved by the progress of the greatest tunnel in the world, and in his death at the age of only fifty three years, the engineering profession lost a member of singular ability. He was one of those men who unite the skill of the experienced engineer with that of the contractor, and are thus often the real authors of the success of the work they do under the names of others.

Already another Alpine tunnel is projected, and no doubt the successful progress of the St. Gothard tunnel has been the chief cause of the proposal to connect the Swiss railway system with that of Austria by a line running along the right bank of the Inn between Innsbruck and Landeck and Bludenz, through a tunnel in the Arlberg of the Rhaetian Alps. The object is to render the two countries independent of the South German railways, over which the traffic is now directed. A further advantage is that the line would enable Austrian and Hungarian breadstuffs to compete in Switzerland and Eastern France with corn coming from Russia *via* Genoa and the Gothard Railway. The new line is divided into two sections—the first running from Innsbruck to Landeck, the second from Landeck to Bludenz. The former will be 72 kilometers long. Its construction presents no extraordinary engineering difficulties; the greatest gradient is 1 in 110, and the sharpest curve makes a radius of 300 meters. The cost of this section is computed at 7,600,000 florins, equal to 105,560 florins per kilometer. The stretch between Landeck and Bludenz will be a mountain line from first to last. In the valley of Rosanna the gradient is 1 in 40. The road will cross the valley of Panznau on a viaduct of three arches, each having a span of 60 meters. The length of this stretch is 54·75 kilometers, the total estimated cost 11.7-4,000 florins, equivalent to an outlay per kilometer of 2·6,900 florins. It is expected that it could be completed within four years from the time of commencement. At St. Antoine, 525 meters above Landeck, will begin the great tunnel. The tunnel, according to this project, will have a total length of 10·270 kilometers, and open on the eastern side of the mountain at a height above sea level of 4,036 feet. Its culminating point will be 4,060 feet, and its opening on the eastern or Swiss side 3,766 feet over the level of the sea. Between the mouth of the tunnel and Bludenz the line will be carried by viaducts over the ravines of the Hollen and the Schmidt, and through two minor tunnels—one 170, the other 120 meters in length. The estimated cost of the great tunnel is 16,246,000 florins, being at the rate of 1,580,000 florins per kilometer. The period of construction is computed at from five to six years. The total length of the line will be 137 kilometers, its total cost 35,630,000 florins, and the mean outlay per kilometer 260,620 florins. This line may not be constructed, but the project was some time since laid before the Austrian Parliament, and is looked upon with much favor. —*The Engineer.*



THE CONSTRUCTION OF A NEW FOUNDATION FOR WASHINGTON MONUMENT.

A JOINT commission for the completion of the long delayed Washington Monument, Washington, D. C., was created by Act of Congress, Aug. 2, 1876. Lieutenant-Colonel Thos. L. Casey, United States Engineers, was placed in charge of the work by a special order, dated June 25, 1878, with Capt. Geo. W. Davis, 14th Infantry, as Assistant Engineer. A month later the former reported plans for strengthening the foundation of the monument, to the end that it might be carried to a height of at least 525 feet above the present top of the foundation; and in the following October the work was begun.

The original work had been suspended when the shaft had reached the height of 156 feet 4½ inches above the top of the foundation, which was 23 feet 4 inches deep. The shaft was 55 feet 1⅛ inches square at the base and tapered to 48 ft. 9⅝ inches at top. The interior space was 25 feet 1 inch square from top to bottom. The bottom of the foundation was 7 feet 8 inches below the level of the ground about the structure. The estimated weight of the structure was—shaft, 23,794 tons; foundation, 8,139 tons; earth on foundation, 243 tons; total, 32,176 tons. This weight was distributed over a bed of foundation, 6,400 square feet in area, giving a pressure of 5,027 tons to the square foot.

Should the obelisk be carried to the proposed height of 525 feet, and the earth filled upon the foundation to the level of the bottom shaft, it was estimated that the pressure upon the bed of the foundation would be 54,093 tons, the weight of the shaft being 43,421 tons; foundation, 8,139 tons; roof and stairs, 250 tons; earth on foundation, 2,283 tons. With a wind pressure of 55 pounds to the square foot, the pressure along the outer edges of the bed of the foundation would be increased to nearly 10,000 tons per square foot, a pressure which the materials used would be incompetent to withstand. A considerable widening and deepening of the foundation was therefore proposed.

In an official report dated Dec. 1, 1879, the engineer in charge described the work done during the year ending Nov. 30. The work of preparing and putting in place the necessary machinery—derricks, engines, concrete mixers, etc.—was completed at the end of the year, 1878, and the materials required—cement, sand, pebbles, broken stone, and lumber—were in place by the latter part of January following, when the excavations for uncovering the old rubble foundations upon the east and west sides of the monument were begun.

Upon the 10th of February, the excavations of the first two cuts for the concrete slab to be built beneath the old foundation were commenced simultaneously near the northeast and southwest angles of the foundation, and they were speedily excavated and filled with concrete. The next two cuts were located on the east and west sides near the southeast and northwest angles; but the removal of 144 square feet of bearing surface from beneath the old foundation was found to give such rapid motion to the structure that after the completion of the masses of concrete in these cuts, and until the end of the work upon the sides, only one cut, involving a removal of but 72 square feet of bearing surface, was undertaken at one time.

The entire mass of concrete beneath the old foundation was completed on the 1st of November, 1879. It is 126 feet 6 inches square, 13 feet 6 inches in depth, and extends 18 feet within the outer edge of the old foundation, and 23 feet 3 inches without the same line. The mass contains 7,037 cubic yards of Portland cement concrete, of a mixture by volume of one part cement, two parts sand, three parts pebble, and four parts broken stone. This concrete possesses a crushing strength, when seven and a half months old, of 155 tons per square foot.

For the construction of this concrete sub-foundation, 10,332 cubic yards of earth were removed, and 70 per cent. of the area of the earth upon which the monument was standing was taken from beneath it and replaced with masonry. The structure settled under this operation as follows:

	Inches.
At the southwest corner	1·836+
At the southeast corner	2.196+
At the northwest corner	1·704+
At the northeast corner	2·053+

The greatest difference of settlement between any two corners, that of the northwest and southeast, was less than one-half an inch, and was in favor of straightening up the monument, a slight leaning to the northwest having been observed in former surveys.

The second part of the strengthening of the foundation, namely, the construction of a continuous buttress beneath the shaft, and extending out upon the concrete slab so as to distribute the pressure of the shaft over the new bed of foundation, was commenced in September, 1879, and at the date of the report had been completed to the following extent: On the north side, 10 feet in running length had been built; on the east side, 10 feet; on the south side, 10 feet; and on the west side, 16 feet 6 inches.

In addition to the above, the portion of this buttress under the northeast angle of the shaft was finished, as was also the rock excavation for a similar portion under the southwest angle. The quantity of rock excavated from the old foundation for these portions of the buttress was 626 cubic yards, and the quantity of concrete built into the buttress, 877 cubic yards. This concrete is of the following mixture by volume: One part cement, one and a half parts sand, two and one-fourth parts pebbles, and three parts broken stone.

The area of the bed of the new foundation is two and a half times that of the old bed of the foundation.

The necessary projects and plans for constructing the interior stairway and for arranging the mechanism to be used in the hoisting and setting of materials upon the top of the shaft were decided upon by the commission in June, 1879, and the floor of the shaft has been prepared for the reception of the ironwork in accordance with that project.

This involved the construction in the floor of the shaft of a pit 16 feet 6 inches long, 10 feet wide, and 7 feet 10 inches in depth, for a winding drum to carry the hoisting ropes, and the location of the foundation stones to receive the phœnix columns of the stairway and elevator wells.

Up to Dec. 1, 1879, there had been expended in strengthening the foundation $87,904. To complete the foundation and carry the shaft to the proposed height of 500 feet of masonry, with an iron and glass pyramidon roof of 25 feet, will cost, it is estimated, about $200,000. The engineer thinks that the work can be finished by the spring of 1883

THE GREAT TUNNEL UNDER THE HUDSON RIVER BETWEEN NEW YORK AND NEW JERSEY.

THE great work of tunneling the Hudson River so as to establish direct railroad communication between the business center of New York city and the West and South, by way of the Erie, Pennsylvania Central, New Jersey Central, Delaware, Lackawanna and Western, and other railroads, is now in active progress.

The tunnel is being constructed by a corporation having a capital of ten million dollars, and under the name of the "Hudson Tunnel Railroad Company." It is organized under the laws of the States of New York and New Jersey, and its stated purpose is the construction of a railroad through a tunnel under the Hudson River, connecting the city of New York with Jersey City.

The active manager of the corporation is its President, Dewitt C. Haskin, an energetic gentleman of large practical experience, under whose able direction the work has thus far been conceived and prosecuted.

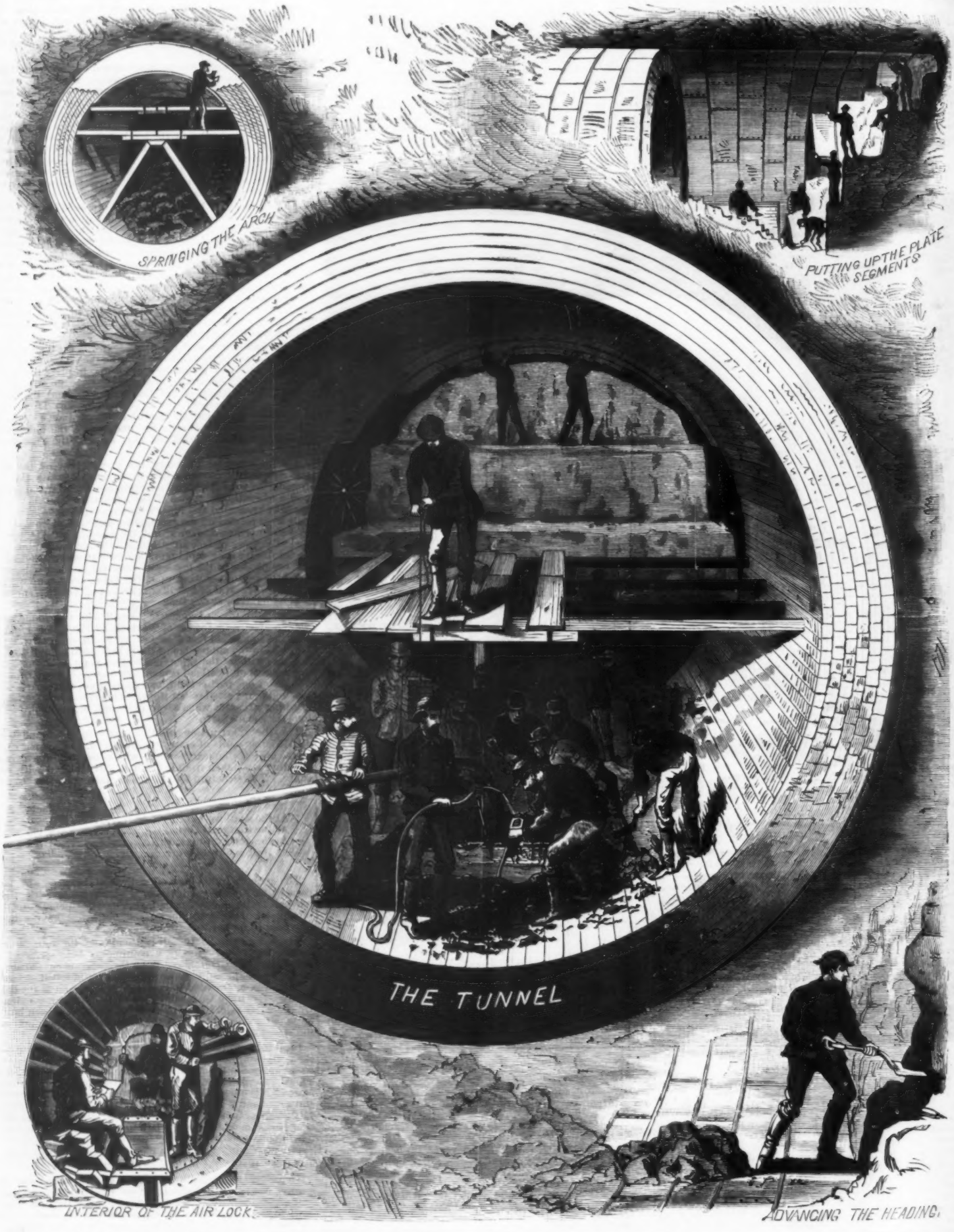
Fig. 4 is a cross section of the Hudson River, showing, also, a profile of the tunnel and the working shafts on each side of the river. The level of mean low water is shown, and the depths in feet to the bottom of the river and to the inner bottom of the tunnel are marked in figures at each station, 100 feet apart. The location of the hard bottom of the river is also indicated.

The greatest depth of water is 60 feet. The borings show that the soil through which the tunnel will pass is for the most part a tenacious silt, underlaid by hard sand. Near the New York shore a small extent of rock is encountered and some gravel. The tenacious character of the soil is considered favorable for tunnel construction, and no serious difficulty of any kind is anticipated by the company.

Fig. 1 shows a sectional elevation of the vertical shaft on the Jersey City side, the temporary entrance to the tunnel, and the tunnel itself, as now building, also the machinery and apparatus in actual operation, including the air lock, elevator, boilers, electric machine, air compressors and receivers, hoisting engine, force pump, brick and cement shutes, the miners excavating and blowing out the material and putting up the iron plates, the masons laying brick, the laborers handling materials, etc.

Fig. 5 is a plan, or horizontal projection, showing the connection between the single and the double track tunnels, when completed, at the working shaft.

The other figures show a cross section of the completed single-track tunnels, with railway tracks and the largest size Pullman car on one side and a man at work on the other; a section of the single-track tunnel, with miners ex-



THE GREAT TUNNEL UNDER THE HUDSON RIVER BETWEEN NEW YORK AND NEW JERSEY.

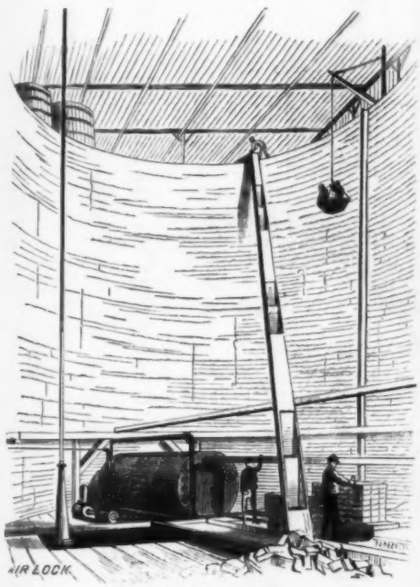
cavating the material and constructing the iron tube, or shell, on one side, and masons laying up brick on the other.

The remaining engravings show the interior of the tunnel, the mode of putting in the iron plates, the inner lining of brickwork, the mode of discharging the excavated earth from the tunnel by air pressure, etc. These pictures explain themselves. Further particulars of this important work are given in the SCIENTIFIC AMERICAN of this week, same date as our present SUPPLEMENT.

New York is a peculiarly situated city. While its geographical location on a narrow island gives it the finest and most extensive water front in the world, this at the same time operates against it by separating it from direct communication with most of its great trunk railroads and many of its steamship landings. When we consider that a city of the commercial importance of New York, containing, with its environs, over 2,000,000 people, receiving three-fourths of the enormous freight and passenger traffic of the great South, Southwest, and Northwest, amounting to three hundred trains daily, is obliged to depend on ferry boats for communicating with most of its great feeders, the necessity for the tunnel at once becomes apparent.

At present the transfer from Jersey City and Hoboken to New York city is constantly obstructed by delays incident to the re-shipment of passengers, baggage, and freight. The ferry boats are interrupted by repeated fogs and ice blockades as well as by other delays incident to navigation.

The Hudson Tunnel Railroad Company proposes to overcome these obstacles by the construction of a railroad through a tunnel of such capacity as to be able to convey all passengers and freight without change of cars and without delay, from all parts of Jersey City and Hoboken into the city of New York. To accomplish this, it is proposed to construct a tunnel with approaches on both sides of the river, the walls to be of the best hard-burnt brick, laid in hydraulic cement; the approaches to be 26 feet wide and 24 feet high in the clear, so as to accommodate a double-track railroad; but under the river, for a distance of about one mile, there will be two single tunnels, side by side, 18 feet high and 16 feet wide in the clear; the whole to be a tube, or shell, of boiler iron, lined with brick.



THE AIR LOCK.

After careful scrutiny, extensive borings and soundings, and a due regard to the wants of the public and the connecting railroads, the location has been made in Jersey City on a line extending easterly from Jersey avenue, on Fifteenth street, to Hudson street, about 3,400 feet; thence curving slightly northward to the New York bulkhead line, at or near the foot of Leroy street, about 5,500 feet; thence curving slightly southward about 3,000 feet to a point to be selected. This route, a little over two miles in length, will cause the least possible injury to existing interests, and the point on the New York side will be the most central, while the materials through which to work, as shown by the borings on this line, are the best that can be obtained in crossing under the river. On the Jersey side, north of this line, the rock comes nearer the surface, and on the New York side the rock is equally prominent.

The grade of the tunnel will be such that at no point under the river will the covering overhead be less than 20 feet in thickness, while within New York city the tracks will not be less than 15 feet below the surface. At no point in New York will the surface be disturbed in the streets except for entrance to and exit from the underground depot. The great obstacle to an undertaking of this magnitude has hitherto been its anticipated expense. The Hudson Tunnel Railroad Company, however, by the aid of compressed air, as applied in the patent therefor, obtained by its president, Mr. D. C. Haskin, in connection with other important appliances, will be enabled to complete this work at much less expense than that at which any similar work has ever been constructed.

The use of compressed air is found to overcome the difficulties usually experienced in similar works, as has been fully demonstrated during the past two months by actual work upon the tunnel.

For the purpose of expedition it is proposed to work from each side of the river at the same time with as many men as can be successfully employed, changing them each eight hours. Thus, by constant work, day and night—this being the way the work has been actually prosecuted during the last two months—it is believed that the tunnel can be advanced five feet from each end every day. If so, the whole work can be easily completed within three years.

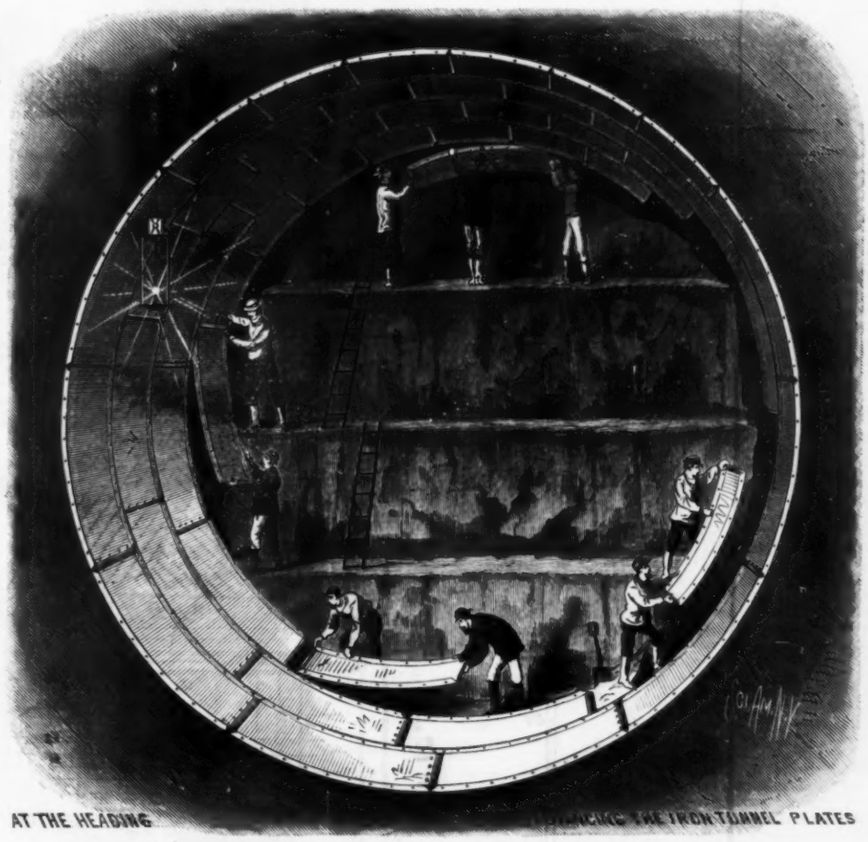
The Hudson Tunnel Railroad Company will then be able to convey passengers from Jersey City to Broadway, New York, without change of cars and in perfect safety, in *six minutes*.

No work of like public importance has been constructed within New York for years. A bridge over the Hudson is impracticable, owing to the great width and depth of the river, and its constant use for the purposes of navigation. If a bridge could be constructed, it must be with a draw, or at such height as to be of no service to the connecting railways. If with a draw, the danger from accident and the frequent delay in travel would be so great as to seriously impair its efficiency. A bridge would also require so much surface room in the city of New York to discharge its passengers and freight that it would be a greater evil than the present inconveniences of transfer by boat. All this will be obviated by the tunnel; and yet, for this vast undertaking, no money is required from the city or State, nor is any subsidy in the form of bonds or credit asked for.

It is only necessary to obtain the necessary legislative permission from the State of New York, all charter rights in New Jersey having been secured. The company asks for a law giving to commissioners power to locate the route of such a railroad and to superintend its construction in New York city, all connecting railroads to have an equal right to have their passengers and freight transported through this tunnel upon equal terms.

Unlike the Brooklyn Bridge, which has cost the public nearly thirteen million dollars, and the Fourth Avenue improvement, costing the city four millions of dollars—both of great public importance—the Hudson Tunnel Railroad, without donation or subsidies, will bring into New York the wealth of other States now by competition sought to be transferred to other channels of trade. This company asks no privileges or rights of way over other companies, but proposes from its own resources to complete its railroad in the interest of no existing corporation, but for the use and benefit of the public.

This tunnel will inaugurate a new era in rapid transit, and will probably lead to other similar tunnels to Brooklyn and elsewhere. Such great improvements are necessarily a benefit to the community at large.



HUDSON RIVER TUNNEL—LAYING THE IRON PLATES.

The officers of the company are

President—D. C. Haskin.
Treasurer—C. G. Lincoln.
Secretary—L. C. Fowler.
Directors—Charles G. Francklyn, Trenor W. Park, C. G. Lincoln, J. S. Wethered, Wm. M. Force, L. C. Fowler, D. C. Haskin.
Engineers in Charge—Spielmann & Brush.
Consulting Engineer—Col. Wm. H. Paine.
Superintendent—J. F. Andersen.

Every additional link in the chain of communication by which access to this metropolis is improved, rendered quicker, cheaper, or better, is a positive and a permanent gain for the city. Every added facility for ingress and egress helps to swell its business, helps to increase both its resident and floating population, helps to build it up as the chief mart of commerce and finance of the New World; and we believe the day is close at hand when railway cars will run under our Hudson with the same frequency as they now run under the Thames at London.

THE GREAT THAMES TUNNEL.

THE railway tunnel now existing in London, and which passes under the Thames River, is, we believe, the most extensive subaqueous structure of the kind ever undertaken, next to the present Hudson River tunnel. The following account of the building of the great Thames tunnel will not be uninteresting. The particulars are from Knight's Cyclopædia:

The Thames tunnel is well known, and has been often described in a popular manner; but as an article on tunnels would not be considered complete without some account of it, we will notice very briefly its history and construction.* It was proposed as early as the year 1798, by Ralph Dodd, the engineer, to open a passage under the Thames, at Gravesend, so as to connect it with the Essex shore. In 1804, Chapman proposed a tunnel at Rotherhithe, and in 1807 a commencement was made, by sinking a shaft at a distance of 315 feet from the river; but the constant influx of sand and water defeated the project. Trevithick was then engaged to drive a way under the bed of the river, and he succeeded in forming a drift 5 feet in height, 2 feet 6 inches in breadth at the top, and 3 feet at the bottom, for a distance of 1,046 feet under the river; but the water broke in upon the workmen, and the project was abandoned until, in 1823, a company was formed to carry into effect the plans submitted by Mr. afterwards Sir Mark Isambard Brunel, which may be briefly stated as follows: A shaft, 50 feet in external diameter, the walls being 3 feet in thickness, was sunk by first driving 24 piles, with a shoulder projecting on the side of each within the circle intended to receive it. On these was laid the timber curb, which also partly rested on one of cast iron, the latter having a sharp cutting edge which entered the ground; through this curb were passed 48 wrought iron bolts, 2 inches in diameter, to a height of 45 feet, equal to the top of the intended shaft. On this curb the shaft was built with bricks laid in cement, and as the work proceeded it was bound together by 26 circular timber hoops one-half inch thick. When the brickwork was completed, another timber curb was placed on the top, and through this the long iron bolts were passed, and their ends being formed into screws, nuts were put on and screwed up, so as to make the shaft as it were one mass. When the cement was sufficiently hard, the earth within the shaft was excavated; 16 of the piles on which the shaft rested were driven in pairs opposite each other, half an inch at a time, and then the whole gradually sunk, carrying with it the other 8 piles. The 16 piles were next drawn out by opening the ground at the back, when the whole weight of the brick shaft=910 tons, then rested on the 8 piles, and these were afterwards drawn when a bed of gravel had been reached. The shaft was thus passed through a bed of wet sand and gravel 26 feet deep. At the depth of 40 feet, the shaft became earth bound, and it was necessary to complete it by *underpinning* the brickwork, *i. e.*, building it downwards as the excavation was carried down. The loose nature of the ground rendered this a matter of difficulty. This lower portion of the wall was increased in thickness to 4 feet, and was built of rag stone, laid in mortar composed of cement and lime, and lined with two courses of brick laid in cement. At the depth of 80 feet an invert was formed, and in the center a smaller shaft, 25 feet in diameter, was sunk still deeper, to serve as a well for water from the drains of the tunnel; but at the depth of about 80 feet from the surface, the ground suddenly gave way, and a quantity of sand and water was blown up.

The excavation for the tunnel was 38 feet wide, and 22 feet 6 inches high, and in order to leave a sufficient depth of ground in the middle of the river above the brickwork, the tunnel was formed with a declivity of 2 feet 3 inches in 100 feet. The ground above was supported while the excavation was going on by a *shield*, consisting of 12 massive iron frames, placed side by side, and capable of being slid forward, independently of each other, for a short distance, by means of screws abutting against the end of the completed brickwork, which followed closely on the excavation. The shield was supported on flat soles, capable of being easily moved forward; the top and sides were also closed in by flat

* There is a very good popular account of the Thames tunnel in Knight's London, vol. iii. The fullest, and in every respect the best account, is a memoir by Mr. Law, in Weale's "Quarterly Papers on Engineering." An abstract of this memoir is given in Weale's "London in 1851;" and also in Mr. Law's "Rudiments of Civil Engineering," contained in Weale's Rudimentary Series.

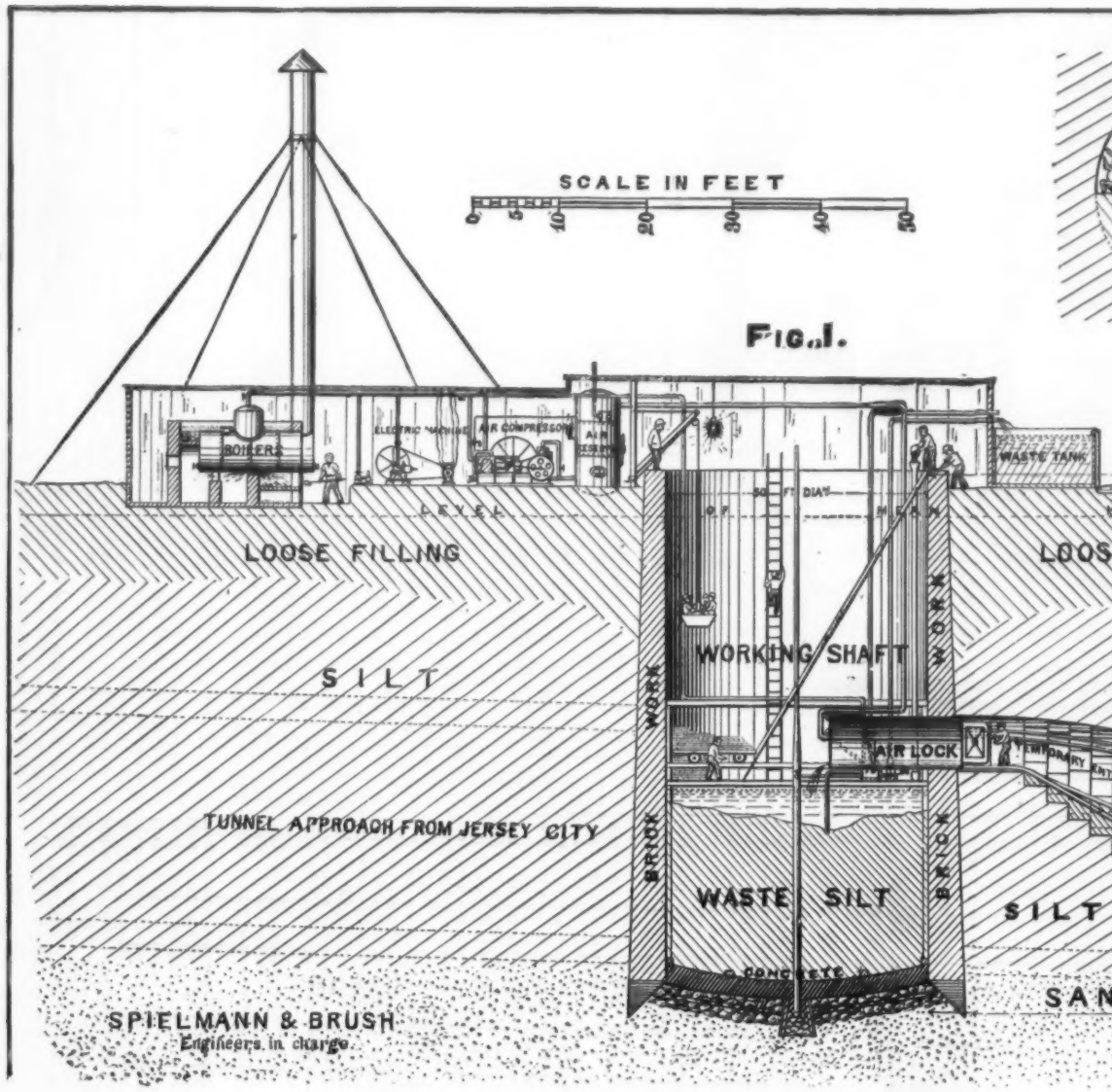


FIG. 1.

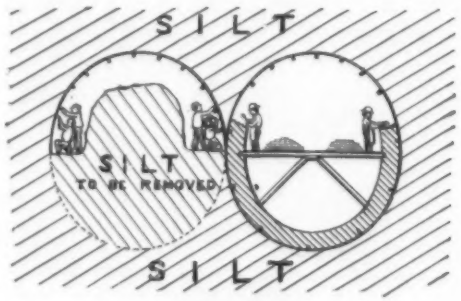


FIG. 2.

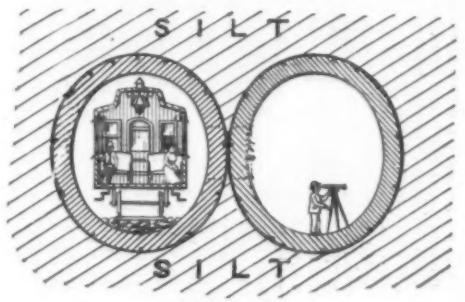


FIG. 3.

THE GREAT RAILWAY TUNNEL UNDER THE HUDSON RIVER, BETWEEN NEW YORK CITY AND JERSEY CITY.

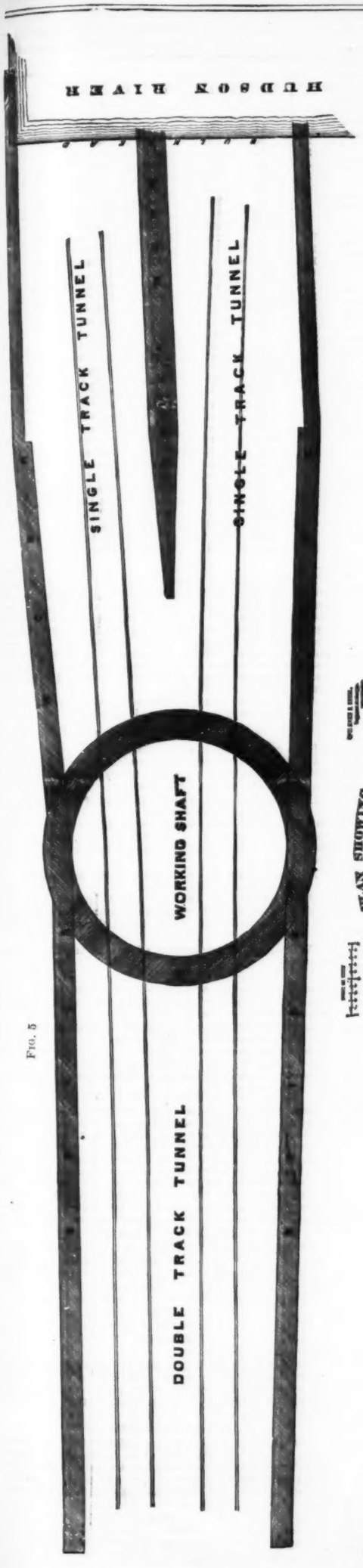


FIG. 5

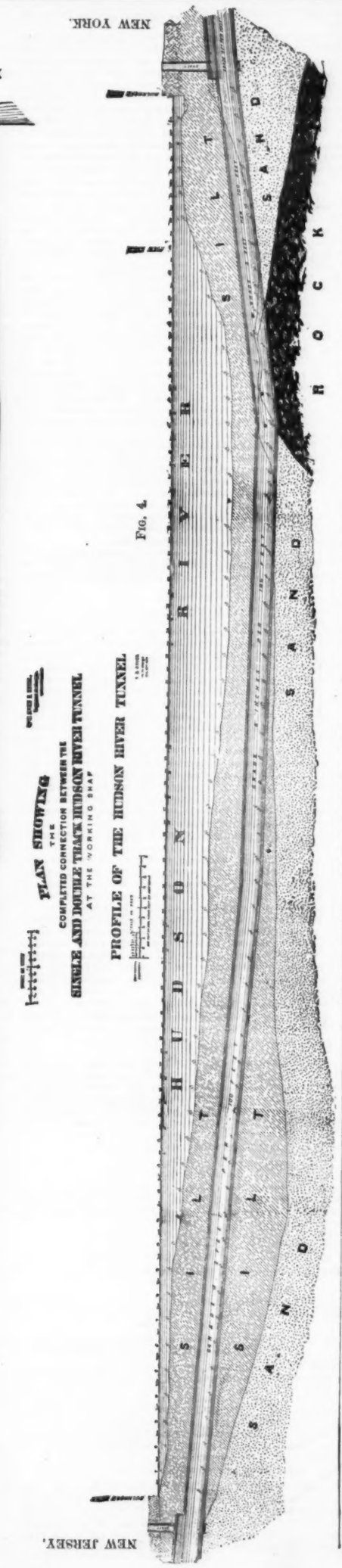


FIG. 4.

PLAN SHOWING THE COMPLETED CONNECTION BETWEEN THE SINGLE AND DOUBLE TRACK HUDSON RIVER TUNNEL AT THE WORKING SHAFT

PROFILE OF THE HUDSON RIVER TUNNEL.

plates, which were supported by massive framing, and also fitted close to the brickwork, by which means the soft earth was prevented from falling in. Each frame of the shield consisted of 3 stories, with a cell in each, in which one man could work; the front of each cell was protected by a series of narrow poling boards, each of which was held in its place by an arrangement which allowed it to be fixed in a vertical line even with the face of the shield, or a few inches in advance thereof. Each miner began operations by removing the upper poling board in his division of the shield, and excavating the small portion of earth thus exposed to the depth of about 6 inches; he then replaced the poling board and caused it to press, by means of jackscrews, against the face of the excavation; he next removed a second board, whereby a fresh portion of earth was exposed and excavated as before. When all the poling boards in one frame of the shield had thus been advanced 6 inches, the frame itself was moved forward, and the same series of operations repeated. The frames of the shield were thus alternately moved forward, slowly and with great caution, the brickwork following close upon the shield, and inclosing two arched passages, 26 feet 4 inches in height from the invert to the crown of the arch, and 13 feet 9 inches span at the springing of the arch. This shield was so damaged in the course of the work that it had to be taken down and a new one raised. The arch, the invert, and the curved side walls, are laid in concentric rings, either a whole brick or a half brick in thickness, each ring presenting a plain face, no bond being employed between the successive rings. The tunnel is built with the hardest picked stock bricks; the first or inner ring of the arch is laid in pure cement, and the other portions of the work in half cement and half clean sharp sand. The bricks for the semicircular portion of the arch were moulded to the true wedge form, so that the bricks radiated with parallel joints between them. The total thickness of the brickwork at the thinnest points where the inclosed arches approach nearest to the boundary of the rectangular mass of brickwork is 3 feet. A solid wall, 3 feet 6 inches thick at the top and 4 feet at the bottom, was constructed between the arches; small transverse arches being afterwards cut through it at intervals to form openings from one tunnel to the other. The whole of the brickwork is laid in Roman cement, and each archway is to be finished with a lining of cement, a carriage road, and a narrow footpath adjoining the central wall. Only one archway, however, has been thus completed. A brick drain is laid down from the center or lowest point of the tunnel to the Rotherhithe shaft, by means of which any water that percolates through may be removed. The inclination of the roadway conducts the water from the other half of the tunnel into the drain.

The excavation of the tunnel was commenced in January, 1826, in a stratum of clay; but in a few weeks much difficulty was experienced, in consequence of meeting with a break or fault, filled with sand and gravel. This obstacle, however, was passed through in 32 days, and by the end of the first year, 350 feet of the tunnel were completed. Moist clay was occasionally forced through the shield. Cavities in the bed of the river had to be frequently filled with bags of clay, to prevent the water from breaking through. In examining the bed of the river, in a diving bell, a shovel and a hammer were left in the river, and these were afterwards found in a mass of loose earth which broke into the tunnel. The works were continued until the 12th May, 1827, when the river broke in with such rapidity and violence, that Mr. Beamish, the engineer on duty, and the men under him, narrowly escaped being overwhelmed. On examining the bed of the river in a diving bell, it was found that about 25,000 cubic feet of earth had been displaced. Tarpaulings were put down over the hole, and filled up with bags of clay and gravel. The tunnel was then pumped dry, and was entered on the 27th June, when the finished part was found to be uninjured. It was not until the end of September that the shield was again advanced; but the progress was very slow; the influx of water was very copious, and on one occasion it amounted, for several hours, to 1,200 gallons per minute. By the middle of January, 1828, another 50 feet had been added to the tunnel, making the length of the finished portion 605 feet; when on the 12th the river burst in so suddenly, and the tunnel filled so rapidly, that of seven persons in the works, Mr. Brunel alone escaped; he was hurried along by the flood, and was carried up the shaft by the rush of water. The hole in the bed of the river was filled up, and on the 12th of April the shield was again entered. By this time, however, the funds of the company were nearly exhausted, and the works were suspended. In order to render the tunnel as secure as possible during the suspension of the works, a solid wall was built at the unfinished end of the arches, so as completely to shut out the river. One arch of the finished portion was lighted with gas, and opened to the public; and it proved, for a time, a very attractive exhibition. After repeated applications, Government consented to advance money for the completion of the tunnel. A new shield was substituted for the one which was injured by the irruption, and from that time, until 1842, the work slowly progressed at the rate of a few inches per week. Three more irruptions had taken place, in one of which a miner lost his life; the same remedy was applied as before, and the bed of the river over the shield was constantly watched, soundings taken at every tide, and bags of clay and gravel thrown in when any depression was discovered. As the tunnel approached the Wapping shore, a shaft was commenced on that side of the river, and the further progress of the tunnel stopped until the shaft was completed, as it was supposed that some settlement in the tunnel might be produced during the sinking of the shaft if brought too close to each other. The shaft was made 75 feet in external diameter at the bottom, and 53 at the top, this taper form being given to prevent its becoming earth bound. On the 13th August, 1841, Sir M. I. Brunel passed from this shaft into the tunnel along a small driftway. By the latter end of November, the middle frames of the shield had touched the brickwork of the shaft, through which it was passed in the same manner as it had passed through the ground. The brickwork of the tunnel was made good to that of the shaft, and on Lady day, 1843, the tunnel was opened for foot passengers. The tunnel is 1,200 feet long between the two shafts. The total cost of the tunnel was £454,714.

MINES AS SOURCES OF WEALTH.

IN a recent lecture in this city before the Women's Bullion Club, by Professor J. S. Newberry, the subject was "Our Mining Industries as Sources of Wealth." Professor Newberry in part said:

Few persons are correctly informed of the immense contributions that are being made from the mineral resources of our country to its rapidly increasing wealth. The history of a country is determined by the resources at its com-

mand, and its future may also be estimated by these resources. How does it happen that England has become so rich and powerful? The secret can be told in a few words. Years ago it was discovered that coal was a great power in the world. England produced this coal, and its large production has been like hundreds of laborers working unceasingly and without pay for their country's prosperity. So it is to be with us. The coal areas of the United States are most extensive, stretching over 150,000 square miles. This is the mainspring of our power. The future greatness of the American nation must come from these very coal fields. The valley of the Mississippi is to be the central home of the American people. All parts of it can be cultivated, and its mineral value is wonderful. Linked with the coal inseparably is iron. From Canada down to Alabama there extends a great belt of iron ore, while at Lake Superior, in Missouri, and elsewhere, we find large deposits. There are no such elements in any other country for the purpose of working out a great civilization.

But these two great minerals are our bread and butter, I might say, and there are other things needed. Gold and silver are included in our inheritance. Not long ago it was said that we had no gold. Since 1847 we have produced fifteen hundred million of dollars worth, and since 1859 we have produced four hundred and twenty-seven million of dollars worth of silver. Thus these United States have become more productive than the rest of the world combined. Coal and iron we have in superabundance, and it would be an easy matter to glut the market with them. But of gold and silver it is not so. They maintain a uniformity of value much better than the others. In the hills of the far West there have been discovered the greatest stores of precious metals to be found in the world. The Rocky Mountain range is saturated with silver like a sponge. We have only begun to draw from its treasures. In the Sierra Nevadas we find the great gold beds from which fifteen hundred millions of gold had been taken, and they are by no means exhausted. Our mining interest is becoming a legitimate and important branch of industry, inferior to no other, and it will add to our wealth gradually for years to come. Of the present production of this country the following it is especially well to know: That from coal $100,000,000 is received; from iron, $95,000,000; from copper, $8,000,000; from lead, $5,000,000; and from mercury, $2,500,000. There has been an outcry that there would be an over production of silver. But past history shows us that this cannot be the case. At Leadville, it is at present easy of access, but it is not so elsewhere. There are no indications of an over supply, but there will be a steady flow of gold and silver, varying from $75,000,000 to $100,000,000 annually for years to come. The result of all my observations for the last twenty years is that gold and silver will not glut the market.

SMOULDERING FIRE AND SPONTANEOUS IGNITION.

WE commented last month on smouldering fire in cotton, and now add, in connection therewith, that about five months since two extensive grain warehouses in Philadelphia were totally burned, and a large quantity of grain and much timber were buried under the falling brick walls. The ruins not having been cleared, nor covered from the dampness of the season, the partly-burned grain and timber have remained smouldering ever since the fire—at times, and even quite lately, sending up dense masses of smoke; and it is still rising at this writing, though not to so great a degree as previously. The Board of Health, at its session, March 2, declared the condition of these ruins a nuisance, and resolved that the owner be notified to abate the same without delay. A long continuance of smouldering fire happened after the great conflagration in Tooley street, London, the buildings in that instance having contained mostly oils, drugs, cotton, and jute. The fire there smouldered for several months, sometimes breaking out dangerously, so that the engines had to be called into service. At the ruins of the two large paper warehouses recently burned on Sixth street, below Market, Philadelphia, it was nearly two weeks before the paper and timber covered by fallen brick walls ceased to throw out volumes of smoke.

In respect to the general question of fires, it would help to decide origin if more attention were paid to tracing carefully fires which developed after smouldering for hours, or perhaps days. Accurate information and data on this subject, as to the substances likely to thus smoulder, and their general habitudes, would eliminate much worthless opinion on the subject of fire causation. On cursory view, the substances most likely to develop, or to continue, such slow, insidious burning, we find to be those which are often packed and compressed very closely in bulk, such as hay, grain, rags, cotton, and some drugs and dye stuffs.

As regards the first-named important product, we are all familiar with the danger of its deterioration in quality, and its heating when housed too soon, or packed in the mow or compressed bales before being thoroughly cured. A cloud of moisture, though but slight, arising from the ricks, or through cracks of ventilators of barn roofs, where damp hay had been stored, has doubtless frequently attracted electricity during thunder storms, causing fires, where otherwise the lightning would not have struck. Smouldering fires in damp hay have also caused destruction imputed to incendiarism. It is not difficult to understand how such heating and smouldering occur, for average meadow hay contains 14·3 parts water, 79·5 parts combustible matter (gluten 8, starch, sugar, and gum 40, fat 2, wood fiber 30), and 6·2 parts ash. Given an excess of oxygen, through excessive and continued dampness, always increased by compression, and the (oxy) carbohydrates, starch, sugar, and gum, soon, by absorption of oxygen, commence to ferment, and spontaneous combustion is imminent. Slow drying and sufficient exposure to air form the treatment which renders hay not only safe from fire, but preserves to it a much larger proportion of nutritive parts, which rapid drying wastes, or which fermentation changes and ruins.

In some parts of Europe, what is called *brown hay* is largely made, by storing grass, etc., in a half-cured state, and so regulating and watching it that a partial combustion does ensue, as indicated by the color; and the mass becomes not only cured, but *cooked*, and so compacted together that it can be chopped with an ax, like wood. Here there is a considerable loss in weight over ordinary curing, but rough plants and grass, otherwise scarcely fit for fodder, can, by mixing among good grass, and being thus treated, add largely to the winter forage. We think the making of "brown hay" an economical measure carried on at great risk. Fortunately, in the United States, territory is so extensive, and grasses and clover so abundant and superior, that there is no need for such cooking of hay, and it is almost unknown here. It would be interesting to know how much the greater relative agricultural insurance in Europe may be necessitated from accidents arising from this cause.

If hay, as ordinarily stored, is salted in proportion of about a peck of salt to the ton of hay, the latter becomes more palatable to the animals. There is also a greater advantage from this mode of treatment of grass and clover; for if, when thus stored, they are too damp (not wet), the salt appears to correct any tendency to fermentation, probably by the evolution of hydrochloric acid when heating commences.

Cotton rags, cotton in fiber, and grain, are so similar in cellular construction and chemical constituents to hay, that similar reasons will cause their heating, deterioration, and perhaps continued smouldering, after being heated and compressed. Unginned cotton, if stored too soon and too closely, or if allowed to become wet, is as quickly injured and fired as hay; the seeds being very oily in nature, the hydrogen therein gives a greater tendency to unite rapidly with oxygen than is possessed by the cotton fiber alone. Woolen rags are generally never packed so tightly as cotton rags, and are naturally less inflammable, but equally subject to spontaneous ignition when excessive dampness, grease, and compression are present to aid or occasion heating.

The principal vegetable dye-stuff which, for reasons advanced, it is needful to guard against dampness, is catechu. As to logwood and other dye-woods, which, when chipped, are treated to a certain amount of water sprinkled over the dry, new wood, it was once surprising to us that manufacturers and dyers should prefer a heavier, damper dye-wood, to one perfectly dry, since the water must be paid for as wood. These dampened woods are packed in barrels or bags, and not compressed. On consideration, we are led to believe that a change similar to that named in "brown hay" occurs in the dampened dye-woods, causing a chemical change which improves the dyeing quality; otherwise, it is reasonable to believe that the dampening would be resisted as an imposition.

It is rather remarkable that the *natural* grease of wool has no tendency to create spontaneous combustion, no matter how tightly compressed may be bales of unwashed wool, how hot the holds of vessels, or how long the voyages. If dampness ensues from sea water or rain, of course heating arises. Some Australian and South American wools contain as much as 80 per cent. of grease and dirt, and the unwashed California wools almost equal that, and are often compressed very tightly in iron-hooped bales.

There is a wide field for investigation in this subject, and in the chemical changes and consequent danger which we have here briefly sketched.—*American Exchange and Review.*

MULTIPLICATION SIMPLIFIED.

ON page 184 of our last volume we published some rules for the simplification of multiplication, which were translated from our Spanish contemporary, the *Cronica Cientifica* of Barcelona. A recent number of the same periodical contains an article by Señor J. M Bofill, who, after a study of these rules, finds that they are in effect only the expression of three particular cases comprised in one general law applicable to the resolution of an infinite number of problems of multiplication of two entire numbers, either digits or composed of an equal or unequal number of figures of equal value, although those of each factor be different. It would be too tedious and uninteresting to enter into the details of the processes by which the author has been led to discover this law or general rule, and we may therefore proceed at once to a synthesis of the problem, to show its truth, and afterwards illustrate it by the resolution of some practical examples, and among others those cited in the previous article.

Supposing the principles of multiplication to be known, it is evident:

First, that any digit whatever, multiplied by another number whose figure or figures are *units*, will give a product formed of as many figures equal to that of the first factor as there are *units* in the second. Thus, the product of 3 by 1 is 3; that of 4 by 11 is 44; that of 5 by 111 is 555.

Second, Inversely every number formed of a single figure, or of many of the same value, may be considered as a product divisible into two factors; one of them will be a digit and equal to the figure or figures of the number proposed, and the other will be formed of as many *units* as the said number contains figures. Thus 555 is a product whose factors are 5 and 111.

Bearing in mind, on another hand, that the product of two products is equal to the product of its four factors, we may establish the following

GENERAL RULE.

The product of any two whole numbers whatever, either digits or compounds of an equal or unequal number of figures of equal value, although those of each factor be different, is equal to the product of two products, or to that of the other four factors. Two of these will be digits and equal to the figures of the unities of the proposed factors, and the other two will be numbers which have as many *units* as each one of the same factors has figures.

$$\text{Formula } P = n \times n' \times 1 \ldots \times 1 \ldots.$$

P being the product sought for, n and n' the ciphers of the unities of the proposed factors, $\times 1 \ldots \times 1 \ldots.$ numbers formed of as many *units* as each factor has ciphers.

If $88 = 8 \times 11$,
and if $333 = 3 \times 111$,
we have $88 \times 333 = 8 \times 3 \times 11 \times 111$.

Examples to prove the general rule:

I. $3 \times 4 = 3 \times 4 \times 1 \times 1 = 12$.
II. $2 \times 22 = 2 \times 2 \times 1 \times 11 = 44$.
III. $33 \times 55 = 3 \times 5 \times 11 \times 11 = 1815$.
IV. $44 \times 777 = 4 \times 7 \times 11 \times 111 = 33088$.
V. $999 \times 555 = 9 \times 5 \times 111 \times 111 = 554445$.
VI. $88 \times 6666666 = 8 \times 6 \times 11 \times 1111111 = 586666608$.

It will now be seen how, by the aid of this general rule, the particular examples given in the preceding article are resolved.

Example 1st. $11111 \times 11111 = 123454321$.
We say that $11111 \times 11111 \times 1 \times 1 = 123454321$.
Example 2d. $99999 \times 99999 = 9{\cdot}999{\cdot}800{\cdot}001$.
We say that $11111 \times 11111 \times 9 \times 9 = 9{\cdot}999{\cdot}800{\cdot}001$.
Example 3d. $999 \times 666 = 665{\cdot}334$.
We say that $111 \times 111 \times 9 \times 6 = 665{\cdot}334$.

Founded on the above rule, the following table has been constructed by the author for the purpose of simplifying the multiplication of such numbers as those stated. Its construction will be seen at a glance, and once lost or forgotten it may be easily written out again by the aid of the principles here explained.

TABLE

for rapidly finding all the products possible between factors which contain figures of equal value.

I.	II.	III.	IV.	V.	
1	11	121	1221	12321	.....
2	22	242	2442	24642	.....
3	33	363	3663	36963	.....
4	44	484	4884	49284	.....
5	55	605	6105	61605	.....
6	66	726	7326	73926	.....
7	77	847	8547	86247	.....
8	88	968	9768	98568	.....
9	99	1089	10989	110889	.....
10	110	1210	12210	123210	.....
12	132	1452	14652	147852	.....
14	154	1694	17094	172494	.....
15	165	1815	18315	184815	.....
16	176	1936	19536	197136	.....
18	198	2178	21978	221778	.....
20	220	2420	24420	246420	.....
21	231	2541	25641	258741	.....
24	264	2904	29304	295704	.....
25	275	3025	30525	308025	.....
27	297	3267	32967	332667	.....
28	308	3388	34188	344988	.....
30	330	3630	36630	369630	.....
32	352	3872	39072	394272	.....
35	385	4235	42735	431235	.....
36	396	4356	43926	443556	.....
40	440	4840	48840	492840	.....
42	462	5082	51282	517482	.....
45	495	5445	54945	554445	.....
48	528	5808	58608	591408	.....
49	539	5929	59821	603729	.....
54	594	6534	65934	665334	.....
56	616	6776	68376	689976	.....
63	693	7623	76923	776223	.....
64	704	7744	78144	788544	.....
72	792	8712	87912	887112	.....
81	891	9801	98901	998001	.....

It will be remembered that it has been shown that every product between factors of equal ciphers is a product of two products, and that one of these always has two digital numbers for factors, and the other has two numbers whose ciphers will always be *units*. Then the 1st vertical column contains all the products possible between two digits, and the first horizontal column contains all the products possible between two numbers whose ciphers are units. The products of these products will be found at the points of convergence of the two columns.

A few practical examples will serve better than diffuse explanations to show how the table is to be used.

1. *To Find a Product Contained in the Table.*

I. To multiply one digit by another.

It suffices to know the multiplication table. The product will be found in the first column, which serves as a guide or numerical order for the other cases.

II. To multiply a digit by a compound of two figures; for instance, $8 \times 33 = 264$.

Multiply mentally the units of both factors and we have $3 \times 8 = 24$. Look for 24 in the first column, then proceed horizontally to the second, where will be found the product sought.

III. To multiply two compounds of two figures each: for instance, $33 \times 77 = 2541$.

Multiply mentally the units of both factors, say $3 \times 7 = 21$. Look for 21 in the first column, then proceed horizontally to the third column, where will be found the product sought for.

IV. To multiply a compound of two by another of three figures:

for example, $22 \times 909 = 21978$.

Proceeding as before we have $2 \times 9 = 18$. Look for 18 in the first column, then proceed horizontally to the fourth column, where will be found the product desired.

V. To multiply two compounds of three figures each: for example, $888 \times 666 = 591408$.

As before, we multiply the digits $8 / 6$ and obtain 48. Now look for 48 in the first column, and in the corresponding horizontal line we will find in the fifth column the product.

2. *To Find a Product not Contained in the Table.*

Since the largest products possible in this table result from multiplying two factors of three ciphers each, when it is desired to multiply factors containing a greater number of ciphers they must be divided into periods of two or three each. Then look in the table for the partial products of each period of the multiplier by all those of the multiplicand, and set down the partial products one under the other, so that the *unit periods* will correspond with their like, the *tens periods* with their like, and so on, and then add them together. The sum will be the product sought. Example:

$$441 \times 555{\cdot}555 = 246666420.$$

Divide the factor of six ciphers into two periods of three each. Find by means of the table the first partial product of the other factor by that of the first period to the right, and set it down. Then find the second partial product and place it beneath, and add the two together, as follows:

246420
246420
246·666·420,

the product sought for.

The application of the table may be further extended; and by the same process, we may multiply two factors whose ciphers are not the same, but whose periods have ciphers of equal value, although the periods are distinct from each other. For example,

$$333 \times 99\,222 = 33040926.$$

Divide the factor containing five ciphers into two periods —one of *nines*, and the other of *twos*. Find by means of the table the first partial product of the other factor by the right period, and set it down. Now find the second partial product and write it down beneath, and add the two together. Thus,

73926
32967
33·040·926,

the same being the product sought for.

PROGRESS OF THE SOUTHERN PACIFIC.

We learn from the officers of the road, that the road will be completed to Tucson, Arizona, this month, whence a branch line to the northern boundary of Mexico will be built after the completion of the main line to El Paso. This branch will extend 70 miles from Tucson to the Mexican boundary via Tabac. The main line, which is nearly completed to Tucson, will be finished to the Rio Grande at Fort Thorn in about twenty months, a distance of 300 miles; and from there to El Paso, a distance of 350 miles, in two years more, with the present force of 2,500 men, largely Chinese, whom the company find it most satisfactory to employ.

In two years, therefore, it will have an eastern outlet via Colorado, and in four years via St. Louis over the south-western system from that city. Should the Texas Pacific be then completed it will also have an outlet through Texas and probably to New Orleans via Houston and San Antonio. With the sale of the bonds, which was so successfully closed last week, and the capital already invested in the road by its projectors, the completion of this line is therefore an assured fact, and not dependent upon the raising of the funds necessary, as in the case of most other Pacific Railroad projects whose securities are now offered to the public.—*American Railroad Journal.*

STEAMBOAT WHEELS.

A CORRESPONDENT of the *American Ship*, in answer to an inquiry in regard to the proper proportion of steamboat-wheel face to diameter, states that the following is reliable in its application to ships and boats in the East:

Name.	Engines.	Wheel.	Piston speed to speed of Buckets.	Wheel face to diameter.
S. S. Vanderbilt.....	2-90"×12'	41'd×10'f	1 to 5·4	1 to 4·1
Steamboat Bristol....	110 ×12	38½×12	1 to 5	1 to 3·2
"Drew.....	81 ×15	40×11½	1 to 4·2	1 to 3·5
"Plymouth Rock...	76 ×13	36½×10	1 to 4·5	1 to 3·6
S. S. Olympia.....	40 ×11	28× 7	1 to 4	1 to 4
"Rising Star.....	100 ×12	36×11½	1 to 4·7	1 to 3·1
"Nebraska.....	81 ×12	33½×10½	1 to 4·3	1 to 3·1
Tug Tho. Freeborn...	40 × 8	30×7½	1 to 4	1 to 2·6
Ferry Boat Kings Co.....	84 × 9	19×6½	1 to 3·8	1 to 3
Ferry boat Hoboken..	42 × 9	18×8½	1 to 3·1	1 to 2
"Clifton....	50 ×10	22×9	1 to 3·4	1 to 2·4

From the above-named eleven boats, which have all been successful, it will be seen there is no arbitrary rule, and that the face of wheel to diameter varies from 1 to 2 up to 1 to 4·1, and that the piston speed to speed of buckets at the periphery varies from 1 to 3·1 up to 1 to 5·4.

Ferry boats and tugs have the widest face, and high-speed boats the narrowest. I do not think there is any perceptible difference in propelling the boat, whether the shaft is in the center of her length, or a little aft, or a little forward. It is thought that in the Bristol it is better to have the boilers in the hold, over the buoyancy, and the cylinder near them, so as to have a short steam-pipe, and to have the stroke of engine as long as possible. It would also be a great economy if the compound system were adopted, as in ocean steamers. The proportion of wheel to face diameter on Western boats is as follows: On the New Albany the wheels are 33 feet in diameter, with 12 feet bucket. Among Ohio and Mississippi boats the proportion is nearer 1 to 2, instead of 1 to 3. A fast Hudson river boat, with 12 feet stroke, turns a 30 or 35 ft. wheel, while a Western steamer of 7½ ft. stroke operates a 27 ft. wheel, and a boat with 11 ft. stroke has a 44 ft. wheel and 17 feet face, the former using 14 ft. buckets.

HAND MADE PAPER.

An improved method of manufacturing vat or hand made paper, by which the process is simplified, and better and cheaper can be produced than by any of the present means, is proposed by Mr. T. H. Busbridge, of Maidstone, Eng. In the manufacture of hand made paper, as ordinarily practiced, it is customary, when the pulp has been made into sheets, to suspend the latter in lofts or drying rooms for the purpose of drying them, the process or operation of sizing the paper being effected after it has become thoroughly dry, either by suspending the sheets in vessels containing the size, or by passing them through sizing machines. This method or process is tedious and costly, and a portion of the paper is always spoiled in the course of the manufacture—a fact which has to be taken into consideration in estimating the cost of production of that which is fit for the market; moreover, it is frequently found in practice that the paper has to be passed through the sizing machine more than once, in order to insure its being sufficiently impregnated with size; this involves an additional expenditure of time, and therefore adds to the cost of production. In the new process, the paper is taken at that stage of the manufacture when the pulp has been made into sheets; the latter are conveyed direct from the "pack" to a sizing machine, in which they are sized in a wet state. The intermediate process of drying is thus dispensed with, and the paper, when in a wet condition, takes up the size much more readily and effectively than when dry, and consequently the paper thus produced possesses more strength or stamina than the best hand made paper. By the process of sizing wet, the time required for the operation is considerably diminished; moreover, a much shorter sizing machine may be used, thus economizing space, and it will never be necessary to pass the paper through the machine more than once. The drying of the paper is effected in any suitable manner after it has been sized, and it will be seen that only one drying operation is required instead of two.

ETCHING ON GLASS.

HERR GRUENE, of Berlin, describes in the *Glashütte* his process of etching designs or letters upon glass. As is well known, designs upon glass may be produced by etching it with dilute fluoric acid, after first covering the places not to be eaten with an acid-resisting material. Almost all lacs and oil varnishes will protect glass from the acid for a short time, while by powdering on metal, copal, or other similar fine particles, absolute protection is obtained. Thus, Herr Gruene, according as he protects the glass in parts by varnish or powder, obtains shallow and deep etching on immersing the glass in the acid.

FORGED CHECKS.

SIR HENRY BESSEMER, writing from Denmark Hill to a London contemporary in reference to the forgeries on the Bank of England alleged to have been perpetrated by the man Walters, now in custody, offers the following valuable suggestions, which he states will prove an absolute bar to this species of fraud, without involving any extra trouble, and at a very trifling cost. Sir Henry writes:—"About the year 1833, when I was deeply engaged with plans for preventing the forgery of stamps, bank-notes, and other securities, I proposed a very simple mode of preventing any alteration of the writing in checks and other written documents by means of chemicals. The plan was simply this:—I take any pale vegetable color, say blue, which should be as sensitive to acid reaction as litmus, and with this color I print over the whole surface of the check or other paper a fine engine turned pattern, thus giving to its surface somewhat the effect of a pale tint extending all over the paper, and which in no way interferes with any black printing or writing that may afterwards be put thereon. Such paper may be produced cheaply by the ream, and be used for checks and other purposes where it is desirable to prevent any tampering with whatever may be written thereon. Now, if any attempt should be made by means of chemicals to take out any portion of the writing on such prepared paper, all the surrounding parts touched by the acid solution will at once lose the whole of the blue-printed pattern, which is more sensitive and much more easily discharged than the common writing ink sought to be got rid of, and would thus leave a white patch where all the delicate tracery of the blue pattern would be absent, and consequently the check, with these evidences of the attempt to alter it would itself become valueless, and the would-be forger would simply lose the amount of the check he had spoiled. The old trick of altering the words 'six, 'seven,' 'eight,' and 'nine' by the mere addition of the letters 't' and 'y' and thus increasing the value to sixty, seventy, eighty, and ninety, would become impossible if the check had the word 'units' printed in large pale colored letters extending across it, such checks being reserved for sums under 10*l*."

THE PHOTO-LITHOGRAPHIC PROCESS.

By HENRY BUTTER.

My practice differs in very few details from that described by me more than twelve years ago, but any improvements or modifications I have here set down. The process, as I here describe it, is such as is in general use by me at the present moment.

Two implements are especially useful to the photo-lithographer—the one a plumb-line, the other a spirit level. The drawing or diagram is stretched upon a drawing-board, and the plumb-line is used to ascertain if the board is in a perfectly horizontal position; the spirit level serves for the leveling of the camera. It is needless to add that the axis of the lens should be in a line with the center of the diagram to be copied. If much work is to be undertaken, it is a good plan to have the camera table running on a small tramway, which is at right angles to the upright drawing- board, which may also be a fixture.

I employ a rectilinear copying lens—one of Dallmeyer's—with a focal length of twenty-six and a-half inches; this gives capital reproductions up to twenty-four inches. I focus midway between center and margin. The drawing to be copied for lithographic reproduction should have well-defined black lines, and should not be shaded with India ink, or tinted with flat washes of any kind; it should be properly stretched or pinned out as flat as possible, in order that all the lines may be kept in the same plane.

Tracings on ordinary tracing-cloth can be copied, if clean white paper is put underneath. The lines should be made of a thickness proportionate to the amount of reduction required. In taking the negative, select a situation where diffused light falls upon the drawing, as when the lighting proceeds strongly from one direction the grain on the surface of the paper and the glazed ink lines give false lights and shadows in the negative, causing some of the lines and figures to be broken and confused. The size of the intended copy being determined, it is marked on the ground glass of the camera, and the drawing placed in such a position as to reflect an image which exactly fills the space marked on the ground glass; the right angles at the corners being accurately preserved, which can only be done by keeping the plane of the tincture, or drawing, parallel to that of the ground glass, and the center in a line with the axis of the lens. Small stops are used to get sharp definitions, and some point midway between the center and outside parts of the drawing used to focus by.

The nitrate bath is of the ordinary strength, but made slightly acid to prevent any chance of fogging. The exposure in the camera should be sufficiently prolonged to get a fair deposit of silver, but should not be carried so far as to risk filling up the lines while developing, as one of the most essential conditions to insure success in the subsequent operations is to secure in the negative perfect transparency in the lines representing the drawing, and as much opacity as possible in every other part.

The developing process which has given the best results is the following: Develop, in the first place, by means of a fifteen-grain solution of sulphate of iron, with fifteen minims of acetic acid, and stop the action the moment the lines are distinctly visible. The intensifying is done by Eder and Toth's lead process. After fixing with hyposulphite solution, the film is thoroughly washed with distilled water, and is laid in a filtered solution of—

Distilled water	100 grammes.
Red prussiate of potash.....	6 "
Nitrate of lead	4 "

Only distilled water may be used, for if spring water be employed, this brings about a general precipitate all over the negative.

The negative should be dipped into this bath as soon as it is fixed, and then but a few minutes are necessary for intensifying. If, however, the negative has become dry, then it should be put to soak in water for some hours, before it is put into the lead bath. Even in that case the process of intensifying takes a much longer time. For this reason it is better not to let the negative dry before it is intensified.

During the action of the lead bath, there is deposited upon the silver parts of the picture a faint yellowish-white precipitate, which makes the film appear quite white, and possesses an extraordinary amount of intensity. It is necessary to allow the negative to remain in the lead bath until it has assumed the same amount of density which you require in the end, for the next treatment with sulphide of ammonium is for the purpose rather of rendering the film permanent than to augment its density.

The action that goes on is similar to what takes place in the uranium intensifying process. The silver works as a reducing agent, and the red prussiate of potash passes into the yellow form, which then becomes an insoluble compound—ferrocyanide of lead—with the lead salts that are present. It is now necessary to convert the unstable lead compound into a permanent and, perhaps, more opaque compound, and this is done by the action of the sulphide of ammonium.

After the negative has been taken out of the lead bath and well washed with distilled water, the sulphide of ammonium is applied. In washing, the color of the film should almost become white; and if it is desired to know whether the washing process has been carried far enough a few drops of the rinsings are allowed to fall into a little iron developer. If no blue coloring is to be observed, then the washing has been completely successful. The sulphide of ammonium is employed in the form of an aqueous solution of twenty per cent. strength, and immediately upon its application the image becomes perfectly black. The operator waits until the image is blackened right through, and then the sulphide of ammonium is washed off with ordinary water. In this way the most transparent lines may be secured upon a perfectly black ground. Distilled water should always be used for first washing the plate throughout these operations.

The photo-lithographic paper is prepared by dissolving separately three ounces of the best gelatine ("Nelson's opaque" answers very well) in forty ounces of hot water, and two ounces of bichromate of potash in ten ounces of hot water; the two solutions are mixed together, and should then be kept from the light. When required for use, the beaker or other vessel containing the mixture should be immersed in hot water for the purpose of liquefying the gelatine, which may then be poured into a flat porcelain dish, placed within another containing hot water, and the paper is then floated in the liquid for about seven or eight minutes, the corners being lifted, and all air-bubbles carefully dispersed, so as to insure a perfect coating; the sheet is then raised, drained over the dish, and hung up to dry, after which the process is repeated. Bank post paper is found to be the most suitable, and before its preparation one side should be marked, so as to readily distinguish the prepared surface. The whole of this operation must, of course, be conducted in a dark room.

When perfectly dried after the second coating, the prepared paper should be laid face downwards on a polished lithographic stone heated, or polished steel plate heated, and passed through the press, in order to give it a smooth, uniform surface, care being taken that no light gets to it, to insure which, in this, as in subsequent operations, the lithographic press should be in the dark room, or used at night, or the stone may be lifted from the press, and taken into the dark room each time it is necessary to handle the paper on it, using several folds of yellow paper as backing sheets, to protect the prepared paper during the transit.

The operation of printing is precisely the same as with albumenized paper, extra care being, however, needed that no light reaches the print. As the printed parts are of a yellowish brown color, while the whole surface of the paper is of a deep yellow, the difference between the two is scarcely discernible in the yellow light of the dark room; but the operator must not be tempted to examine the progress in daylight. It is also of the utmost importance that the image should not be over-printed, for if the action of the light extends to the general surface of the paper, it is altogether impossible to succeed in clearing the print in the next process; if, on the other hand, the image be under-printed, there is a great probability of the finest lines being rubbed away.

Inking the print is the next stage in the process after exposure, and again brings the lithographic press into requisition. The greasy ink used may be either the common litho-retransfer ink, with which by far the most satisfactory results have been obtained, or the following: Grind together two pounds of chalk lithographic ink, and one pound of middle linseed varnish, melt in an iron ladle four ounces of Burgundy pitch, and add gradually two ounces of palm oil and two ounces of white wax, stir the mixture till it burns, and then put in the ink and varnish in small quantities at a time, stirring the whole well together. When required for use, a small portion is melted with sufficient spirits of turpentine, so as to give it, when cold, the consistence of treacle.

To ink the print, a polished lithographic stone or polished steel plate (having been cleaned with spirit of turpentine, if it has been used for the same purpose before) is charged with a very thin coating of the ink by means of a litho-roller, and the print laid face downwards upon it, and passed through the press, using a rather lighter pressure than in ordinary printing; on taking up the print it should be found uniformly covered with a thin tint of the black ink; the thinner the layer of the ink, the sharper and finer will the drawing come out.

Removing the superfluous ink is accomplished in the following manner: Prepare some strong gum water, and warm it slightly; pour some hot water (about 100° Fahr.) into a flat porcelain dish, and upon it float the inked print, face upwards, allowing it to remain until the warm moisture has penetrated the gelatinous film—which will be known by the appearance of innumerable glossy patches over the surface of ink; then pour off the water, leaving the print evenly spread on the bottom of the warm dish, and wash it very carefully with a soft sponge and the warm gum-water. If the gelatine is of good quality, the negative sufficiently opaque, and no light has been permitted to reach the print beyond that which passes through the transparent parts of the negative, the coating of gelatine, and with it the greasy ink on its surface, will be removed from the paper with the lightest touch of the sponge, leaving behind such portions of the composition only as have been made insoluble by the action of light, and which, consequently, also retain the ink on them, gum-water being incapable of attacking the grease and removing it from the paper, unless it can do so by first dissolving away the foundation of gelatine upon which it rests.

When all the superfluous ink has been removed the print is washed in several changes of tepid water (not so warm as before), and hung up to dry. A careful examination will now point out any errors in the foregoing process. If the fine lines which lie close together, or the angles formed by the junction or crossing of the lines, are filled in with ink, and the drawing generally appears rough and wanting in sharpness, there has been too much ink on the stone in the inking process; if, on the other hand, the lines are very sharp and fine, but extremely pale and wanting in sufficient body to transfer themselves to stone, there has been too

little (a very rare fault). If the ink leaves the paper sluggishly, and there remains behind a dark scum in patches over the drawing, light has affected the paper, either through the negative being not sufficiently dense (a very likely cause), or from carelessness in conducting the operations. If the lines are broken, and exhibit a tendency to leave the paper, the print has been under-exposed; whilst if the thick lines, dots, etc., are firm, sharp, and well-defined, and the fine ones rotten and feeble, the negative itself is at fault, having its fine lines partly covered up in the intensifying process. This fault is not so easily discerned on looking through the negative as might be imagined, on account of the filling up frequently consisting of a thin yellowish veil, transparent to the eye, but chemically opaque—a fault generally due to over-exposure and carrying the development too far previously to fixing, but occasionally due to insufficiently washing away the hyposulphite of soda in each operation in which it has been used.

The transferring to stone is performed in the same manner as with an ordinary transfer, and does not require special notice.

A PHOTO LANTERN.

PROF. STERBING writes to the *British Journal of Photography:* In all lanterns employed in the laboratory a serious inconvenience may be noticed, namely, that dark lines are formed by the iron supports of the lantern—in fact, the light is distributed very often in a wrong direction. Since the gelatino-bromide plates have been introduced, in which the development of the image is seen better by reflection, a different kind of lamp or lantern has been required. I made

A, Large funnel-shaped tin lantern. B, Reversed funnel to throw light into hemisphere, C. C, Iron dome or hemisphere. D, Reversed funnel. E, Exit of the product of combustion. F, Small lamp. G, Yellow glass flushed with ruby red. H, Wooden handle to carry lantern.

one on the reversed-funnel system, and it has succeeded far above my expectations. In looking at the diagram the whole apparatus can be easily understood. The lantern is intended to be hung up over the developing table. When the little lamp is lighted the bright tin sides of the lantern reflect the light downward, and it gives a brilliant and non-actinic light. I have found it exceedingly useful in my laboratory, not only for development of the negative, but for the preparation of the plates.

AN UNPUBLISHED CHAPTER IN THE HISTORY OF THE MORSE TELEGRAPH.

THE forthcoming annual report of the Smithsonian Institution will contain an important contribution to the history of the electric telegraph, in the shape of a memoir by Professor William B. Taylor, who will be remembered as having been for many years connected with the United States Patent Office, on the discoveries and inventions of the late Professor Joseph Henry, and their relation to the development of the electric telegraph. We shall hereafter take occasion to review this memoir with something of the completeness which its importance warrants. Meantime, our readers will be interested in the following chapter, which we reprint from the appendix to the memoir, advance sheets of which have been placed at our disposal by the courtesy of the author.

It appears from various concurring testimonies that the new recording instrument constructed for Professor Morse by Mr. Vail during October, November, and December, 1837, was entirely of his own design, without any suggestions from Professor Morse; and that its arrangement for discontinuous marking was specially contrived by its maker for an alphabet exclusively devised by himself, which he abstained from publicly claiming, owing to a delicate sense of obligation incurred by his contract with Professor Morse, to render him every assistance in perfecting the mechanical arrangements of the telegraph.*

That Professor Morse had no conception on the 3d of October, 1837, of the form of the instrument contemplated by Mr. Vail, is clearly shown by his autographic "cavent" of that date. And his letter to Mr. Vail, of October 24, announcing the completion of the numbered dictionary (in which he wrote, "We can now talk or write anything by numbers") is equally conclusive evidence that, at this later date, he was still unconscious of any alphabetic improvement.

An article in the New York *Sun*, by its editor, Mr. Moses S. Beach (written in 1858), under the heading, "Honor to whom honor is due," makes the statement: "We will mention a few incidents connected with Professor Morse's own experience which we have never seen in print, and which lose none of their interest from the unassuming modesty of the parties referred to." And after alluding to the assistance furnished the inventor in his early imperfect experiments by the Messrs. Vail, the editor continues: "Alfred Vail entered into these experiments with his whole soul, and to him is Professor Morse indebted, quite as much as to his own wit, for his ultimate triumph. *He it was who invented the far-famed alphabet;* and he, too, was the inventor of the instrument which bears Morse's name. But whatever he did or contrived went cheerfully to the great end. Alfred felt rewarded in seeing the gradual accomplishment of the dream."*

In an interesting article, entitled "The First Week of the Telegraph," written in 1869, for a New York monthly magazine, by Dr. William P. Vail, the following significant allusion to his deceased nephew, Mr. Alfred Vail, occurs: "The birth-time and the birth-place of the telegraph as a recording instrument of *intelligence* . . . the parties who wrought the rude original plan into working order and gave it efficiency, the man *who invented the 'Morse alphabet'* (so called), and to whose ingenuity, mechanical skill, and tireless perseverance the clock-work of the telegraph machine is largely due . . . all this is well understood, and for the most part is written down, and the record some day in the near future must find its place in history, upon the true principle of *suum cuique.*"†

It is noteworthy that neither the published statement made by the editor of the *Sun*, nor that made by Mr. Vail's uncle in the *Hours at Home* (both widely circulated, and copied into other journals during Professor Morse's lifetime), was ever called in question by the celebrated telegrapher. His painful silence under the circumstances is not easily defensible.

Mr. Francis O. J. Smith, one of the partners in the original telegraph patent of Morse (having had as capitalist and business manager a one-fourth interest in the enterprise) has also stated in a published letter, dated March 30, 1872 (not long before Professor Morse's death), that the modified horizontal lever adapted "to emboss the alphabetic characters" was "neither invented nor combined in the telegraph by Professor Morse, but exclusively by our associate, Mr. Alfred Vail; although, for reasons that will be satisfactory to most minds, they were never publicly credited to him, but have been claimed exclusively by Professor Morse as his own invented combination."‡

Dr. Gale, the only surviving member of the original partnership, states in a recent letter on the subject, that he does not distinctly remember whether the changed arrangement of the lever to a horizontal position in the new model constructed by Mr. Vail was his exclusive invention or not.

In a biographical sketch of Albert Vail by Mr. Frederick Brent Read, of Cincinnati, published in 1873, the writer states without qualification: "Alfred Vail first produced in the new instrument the first available *Morse* machine. He invented the first combination of the horizontal lever motion to actuate a pen or pencil or style, and the entirely new telegraphic alphabet of dots, spaces, and marks, which it necessitated; and he did so prior to September, 1837, the month when the old instrument passed into his hands for reconstruction. . . . The new machine was Vail's, not Morse's. The claim is clearly made, then, that Alfred Vail in the first place invented an entirely new alphabet; secondly, he invented an entirely new machine in which was the first combination of the horizontal lever motion to actuate a pen or pencil or style, so arranged as to perform the new duties required with precision, simplicity, and rapidity; and thirdly, Vail invented, several years afterward [in 1844], the new lever and [grooved] roller which embossed into paper the wholly simple and perfect alphabetic characters which he alone originated."§

Numerous experiments with various kinds of pencils, fountain-pens, and inked roulettes, having shown their inefficiency for the uniform marking of the "dot-and-dash" alphabet, Alfred Vail at last boldly discarded all marking devices, and employed a blunt steel point near the end of the registering lever, playing directly over a narrow groove in the roller which supported the record-fillet of paper. In this manner the variable lines of the Vail alphabet were permanently indented in the paper with perfect facility and unerring regularity. Mr. F. B. Read, in his biographical sketch of Samuel F. B. Morse (in the work just quoted), after alluding to his original apparatus as being placed by him "in Mr. Vail's hands for an entire mechanical reconstruction throughout, to speak a language not wholly unknown to the first machine, but to perform entirely new functions and to produce an entirely new system of signs and letters which the first, by its structure, was physically incapable of being made to speak;" adds, with regard to Mr. Vail's subsequent improvement, "His more perfect invention of a steel style upon a lever which could strike into the paper as it was drawn onward over a grooved roller and *emboss* upon it the same alphabetic characters was not made until 1844, about the time the first line of telegraph began to operate between Baltimore and Washington."‖

Simple as may appear the substitution of the dry point for the inked wheel or pen, its introduction effected a wonderful saving of time, of attention, and of annoyance. In a memorandum attached to the original model of the lever style and grooved roller, Alfred Vail wrote: "I have not asserted publicly my right as first and sole inventor, because I wished to preserve the peaceful unity of the invention, and because I could not, according to my contract with Professor Morse, have got a patent for it."¶

Mr. Read, in the same biography of Morse, after quoting his feeble and insufficient tribute to Vail in his speech at the banquet given at New York on the evening of December 29, 1868, in honor of the "successful" inventor (in which he said of his intellectual offspring, "It found a friend in Mr. Alfred Vail, of New Jersey, who, with his father and brother, *furnished the means* to give the child a decent dress") makes the comment: "It would have been more magnanimous if, in those last days of the aged savant, he had stated the precise facts, and given Alfred Vail the full credit to which he was justly entitled. He would thus have generously raised a fitting monument to the memory of one who had, years before, 'been gathered to his fathers' in the prime of manhood, who had, with wondrous modesty and singular reticence, refrained from claiming as of his own invention the improved 'Morse' instrument and alphabet."*

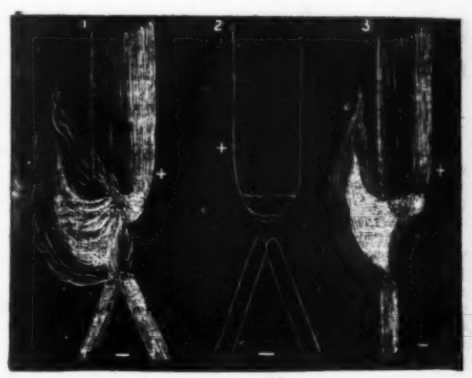
In again referring to this subject in his following sketch of the life of Vail, the author adds: "These are the quiet and subdued terms in which Professor Morse was content to hand his co-inventor and early friend down to posterity. He makes no allusion to Alfred Vail which would lead any one to suspect that he was anything more than a skillful mechanic—that Vail had ever done anything beyond putting into form the conception of Morse's brain. To say the least, it was an unhappy holding off from a magnanimous and generous course."†

At a meeting of the directors of the "Magnetic Telegraph Company," held at Philadelphia on the 16th of February, 1849, for the purpose of giving expression to their feelings on the recent death of Alfred Vail (a brother director), Amos Kendall, in seconding and warmly supporting the offered resolutions of respect and grief, is thus reported: "In the words of the distinguished associate and friend of both, the Hon. Amos Kendall, 'If justice be done, the name of Alfred Vail will for ever stand associated with that of Samuel F. B. Morse in the history of the invention and introduction into public use of the electro-magnetic telegraph. . . . Mr. Vail was one of the most honest and scrupulously conscientious men with whom it has ever been my fortune to meet."‡

Surely it is time that Alfred Vail should receive the tardy justice of some public acknowledgment of his very ingenious and meritorious inventions in telegraphy, and of grateful remembrance, particularly for his valuable contribution to the "Morse system" of its practically most important element.—*Journal of the Telegraph.*

CURIOUS VOLTAIC ARC EXPERIMENT.

WE lately had the pleasure of witnessing a curious experiment, made by Mr. J. Rapieff, with the electric light arc in one of his three carbon lamps. The voltaic arc being started, the end of the upper, or +, carbon was touched with a piece of iron wire, which immediately melted, the molten portion clinging to the end of the carbon by capillary attraction. After a short time the carbon became cup-shaped at the bottom, the molten iron resting in the cup. On drawing out the arc, a curious phenomenon manifested itself, a cluster of small circles, or spots, presented themselves on



the surface of the glistening metal, and flames radiated from them, which eventually lost themselves in the general flame. The drawings illustrate the effect in profile and nearly front view. The center of the flame was of a yellowish tinge, merging into a beautiful purple near the edges. On disconnecting the circuit and allowing the carbons to cool, the iron commenced a pulsatory movement up and down, as indicated by dotted line of Figure 2, and eventually fell to the ground.—*Tel. Journal.*

KING'S ELECTRIC LIGHT.

MR. WIESENDANGER, in the course of his lucid summary of the history of electric lamps, says that "Many years ago, a famous electrician named King, inclosed thin carbon rods in glass tubes," etc. As thirty-four years have passed since I last shook hands with Mr. King, and bade him farewell on his return to America, and have not heard from him since, I cannot say whether he is still living; but if so, he will be amused if he meets with this description of himself as "a famous electrican." He was simply an enterprising and very intelligent American capitalist, who, in conjunction with a Mr. Dorr, also a similar American, believed in 1846, as so many now believe in 1880, that the electric light was "the light of the future." These capitalists also invested in other inventions for lace-making, tanning, etc., and came to this country to carry them out commercially.

The actual inventor of the lamp patented in King's name was a young man named Starr, who, had he lived, would doubtless have been a very famous electrician. He was about the ablest experimental investigator I have ever known, and having practically worked with him in connection with the electric light, I am able to speak confidently of his ability. I made for his experiments a Daniell's battery of 100 cells, each with two square feet of working surface to each element. Brilliant results were obtained with this, but the practical difficulties and cost decided Starr to abandon Voltaic batteries altogether, and use permanent magnets with moving armatures of the source of electricity. He was engaged in perfecting his magneto-electric machine, when he suddenly died in Birmingham.

Those who have back numbers of the *Mechanics' Magazine* (April and May, 1846), will find many interesting particulars connected with this invention, and also Snyder's Method of Tanning, in which the same capitalists were concerned. To some of these my name is appended. I may add that when Mr. King and Mr. Dorr left this country the remains of their electric light apparatus were formally assigned to me (in consideration of services rendered) by a deed I now hold,

* By the terms of the partnership in the telegraph, Mr. Vail agreed "to devote his personal services and skill in constructing and bringing to perfection, as also in improving, the mechanical parts of said invention, . . . without charge for such personal services to the other proprietors, and for their common benefit."

* New York *Sun*, for September 25, 1858. Republished in the *Weekly Sun*, for October 2, 1858. In a recent letter on the subject, Mr. M. S. Beach, the author of the above, states: "I was then personally acquainted with the Vails, and a not unfrequent visitor at the homestead in Morristown; besides, of course, having a personal acquaintance with Professor Morse and with the telegraph managers generally. My impression is that the article was at the time approved for its exact statement—*never controverted.*"

† Scribner's *Hours at Home*, September, 1869, vol. ix., pp. 435, 436. In response to an inquiry as to the evidence of Mr. A. Vail's invention of the "dot-and-dash" alphabet, Dr. W. P. Vail, the author of the above, declares in a recent letter, "It was so understood by all who were admitted to his intimacy. In a conversation with him shortly before his death, in 1859, he so assured me. I am not aware that Mr. Morse ever set up an adverse claim."

‡ A pamphlet entitled "History Getting Right on the Invention of the American Electric-magnetic Telegraph," 1872, p. 21. It does not appear that Professor Morse ever did explicitly claim these inventions as his own.

§ A collection of biographical notices entitled "Up the Heights of Fame and Fortune," by F. B. Read, 8vo, Cincinnati, 1873, pp. 270, 271. Thirty-four pages are devoted to an account of the life of Alfred Vail, who died at Morristown, January 18, 1859.

‖ "Up the Heights of Fame and Fortune," pp. 294, 245.

¶ Quoted in same work, p. 291.

* Same work, p. 244.

† Same work, p. 297. A friend of Mr. Vail (unnamed), who visited Professor Morse at his request during his last illness, in March, 1872, is reported as stating, "In a conversation of two hours, he several times said 'The one thing I want to do now is justice to Mr. Vail.' . . . Just four weeks from that day he passed from earth; and I have never heard that he left one word for it. Indeed, I did not expect that he would." To this statement Mr. Read adds, "Here we leave Professor Morse and his relations to Alfred Vail. Our only purpose has been simply to bring the facts concerning this wonderful invention to the light of day." (Same page of the work, p. 297.)

‡ Same work, p. 296.

and that I have shown the original apparatus in action several times to my pupils at the Midland Institute; also in the Town Hall of Birmingham. The vacuum was obtained not by air-pump, as commonly stated, but by expanding the upper part of a large barometer tube, fitting the carbon-stick connected with a platinum wire in this expansion, then filling with mercury and inverting in cup of mercury, thereby obtaining a Torricellian vacuum in the lamp portion of the tube. One terminal of the platinum wire was sealed into the upper end of the tube, and passed through it, the other dipped into the mercury, and thus the connection with the battery was easily effected. I worked it in Birmingham with a Grove battery of 20 cells, each element about 4×3 inches. The light was very brilliant, about half an inch long, and the carbon-stick (made of gas-retort coke) stood firmly, but the glass was dimmed with a carbon deposit.—*Prof. W. Mattieu Williams, in the English Mechanic.*

ELECTRICITY IN WOOL.

A MANUFACTURER, who communicates his experience to the *Deutsche Wollengewerbe*, found that during the process of carding his wool got so electrified that it would not follow the narrow straps which in many continental condensers take the threads off the doffer. After careful observations it was found that the cause lay in the material used for greasing the wool. When the oil was mixed with water and spirits of ammonia it became perceptibly electric, especially with each change of the weather, and became such a nuisance that the spinning operation was seriously inconvenienced. This, however, only occurred with fine wool, which had been shorn unwashed and then had been washed in a soda bath. Since the ammonia has been replaced by soda the inconvenience has almost disappeared, and is only felt with great changes of weather.

PARKESINE, XYLONITE, OR CELLULOID.

A QUERY respecting this substance, what it is, how manufac ured, and the uses to which it may be applied, having appeared a few weeks ago in *Design and Work*, I propose to answer some of these points, especially as it is now so largely made and used in America, and is creating considerable interest in this country. The inventor is Mr. Alexander Parkes, of Birmingham, an experienced experimental chemist, whose versatility of invention and successful application in so many directions, which have made the fortunes of many others, seem almost incredible. More than thirty years ago he was impressed with the necessity for the introduction of a substance to take the place of certain natural productions, such as ivory, tortoise shell, India-rubber, gutta-percha, etc. His attention was directed to the peculiar properties of nitro-cellulose pyroxyline, or gun-cotton, and he set himself to discover a means of combining it with other substances so that it could be successfully applied to the peaceful arts, instead of to the destructive purposes to which, at first, it seemed only applicable. Many thousands of experiments were made by Mr. Parkes with this aim, and in the year 1855 he took out his first patent, being assured that he should soon be able to introduce a new substance for his own enrichment and for the benefit of mankind. Being then much engaged with the extensive metal and other works of Messrs. Elkington, Mason & Co., of Birmingham and South Wales, the matter lay dormant for some time, but afterward had made so much progress, that at the Great Exhibition (London) in 1862, Mr. Parkes showed an extensive variety of samples to prove its adaptability to manufactures, and a prize medal was awarded to him, although the specimens of the uses to which it could be applied were made in a rough manner by himself, without the suitable appliances used in the various trades. The name "Parkesine" was given to it by a French gentleman at the Paris Exhibition in 1867, where Mr. Parkes also showed it, and for which he obtained a prize medal. It had hitherto had no precise name—so it was suggested, "What so good as 'Parkesine?'" and henceforth it was known by that term. It has been lately renamed "Celluloid" in America, and "Xylonite" in England, though "Parkesine" is its original and most appropriate designation.

Pyroxyline, or gun-cotton, is a very remarkable substance, in which cellulose or woody fiber is combined with nitric acid. Mr. Parkes' method was to take 1 cwt. of disintegrated or divided cotton waste, or similar substance, which was to be placed in an open vessel called a converter. Nitric and sulphuric acids were used in the proportion of one part nitric acid, s. g. 1420, to from four to five parts sulphuric acid, s. g., 1845, mixed in a separate vessel, and kept as cool as possible. The mixed acid was pumped or forced up into the converter, and the cotton, being put into a hopper placed over the converting vessel, fell into it through an opening at the top of the converter. By the time the cotton was charged into the converter—usually about ten minutes the cotton was sufficiently changed chemically. At the longest time twenty or thirty minutes would not be exceeded. The nitro-cellulose or pyroxyline, with the acid, was then allowed to fall through an opening in the bottom of the converter into a large box having a false bottom of perforated iron or wire gauze, six inches from the real bottom. On that the mixed cotton and acids were allowed to stand for one hour to allow the excess of acid to drain away. The cotton was freed from the remaining acid by being placed in a cylinder having a perforated bottom, and under a powerful hydraulic press. A hard cylinder of pyroxyline, containing only from 5 to 20 per cent. of acid, was thus obtained, and these cylinders were stored away for future use.

When the manufactured substance was required for future use the cylinders of it were placed in a machine (made for the purpose) to tear or disintegrate them into dust or small pieces. The divided cotton, on falling into a large box, was well washed, and the 5 to 20 per cent. of acid which it contained was washed away. The cotton was again put into a cylinder with a perforated bottom, and the water was removed by hydraulic pressure, so that only from 5 to 20 per cent. of the water remained. The solid hard lump of cotton, now soluble, was broken up in the tearing machine, and, with the 5 or 20 per cent. of water, was dissolved in one or more of the following solvents: Vegetable naphtha (previously distilled off chloride of calcium, manganese, or zinc), nitro-benzole, aniline, camphor, alcohol, or glacial acetic acid, or mixtures of them, sufficient being used to make a soft plastic mass, which was afterward strained through wire sieves, under hydraulic pressure, to separate any solid impurities therefrom. The plastic mass was now, or before it was pressed, mixed with the oils, gums, or colors necessary to produce Parkesine of any degree of hardness or flexibility, or of any color. Chloride of zinc, iodide of cadmium, oxalate of zinc or manganese, and other agents, were employed to prevent the rapid combustion of nitro-cellulose or pyroxyline. These were claimed in the first patent of 1855, and others were patented and made use of subsequently.

The preparation was then put into a rolling machine, closed to prevent the admission of the air, and was heated by steam passing into the roller, and an exhausting apparatus was employed to return the solvents to vessels properly placed for their reception. In from twenty to thirty minutes the charge was sufficiently blended and stiffened to be taken out, and was then rolled by revolving cylinders into sheets of any length or thickness. Or, while in a plastic state, it was formed into tubes or other articles by dies or pressure. The whole of the operations, from the weighing of the one hundredweight of cotton to the finishing into sheets or otherwise, took only from two to five hours, according to circumstances.

A very important advantage connected with this material is that it can be united by means of its own solvent or cement, and in its use there is no waste, as all the scraps may be reworked.

The points of interest and the advantages claimed by Mr. Parkes under his various patents are: "The production of solid masses of Parkesine of all colors, and the use of certain substances to prevent the rapid combustion of pyroxyline;" "the employment of vegetable naphtha, or alcohol, distilled over chloride of calcium or zinc, and the recovery of solvents;" "the first use of camphor, alcohol, nitro-benzole, aldehyde, aniline, or glacial acetic acid, as solvents of pyroxyline, and of the gums used in the manufacture of Parkesine;" "the use of glacial acetic acid, with gelatine tannic acid or gallic acid, and the solution of *wet* pyroxyline, thus saving all the time and risk of drying;" "the solidification of oils by the action of chloride of sulphur;" "the use of hydraulic machinery to expel acids and water, and also to strain the dissolved mass of Parkesine;" "the production of figured and inlaid Parkesine, and the imitation of ivory, pearl, tortoise shell, and other natural substances;" "the use of camphor to assist in rolling the sheets and working up other articles, and in various mechanical arrangements for the production of Parkesine in a cheap and rapid manner;" "the use of iron vessels in making pyroxyline;" and "the application of the new material to the insulation of telegraph wires," etc., etc.

At the French Exhibition (Paris), 1867, Mr. Parkes exhibited a splendid collection of articles made from his new material to illustrate its applicability to a great variety of uses—such as carved and pressed cameos, medallions, book-covers, combs, brushes, tubes of different kinds for various uses, knife handles to imitate ivory or other substances, spinners' bosses, buttons, insulated telegraph wire, portmonnaies, umbrella handles, rules, rough sheets. The colors of some of the articles were most gorgeous, and in the case of tortoise shell and some others appeared an improvement upon the natural productions they were intended to supplant. The various manufacturers who had worked up the material were greatly surprised at its strength, hardness, beauty of color, its capability of being made (according to the mixture) hard or soft, and its unchangeable nature. In its crude form it looks like a transparent glass or gum, and is without color, or is of a light yellow brown. It can be made as hard as ivory, and can be readily moulded into any and every conceivable form. When dyed, which it can be with ease, the dye runs through the entire substance. It can be spread on textile fabrics or other materials—one layer of one color may be spread on another, and beautiful granular or marbled effects may be obtained by roiling variously-colored sheets together while in a slightly plastic state. It can be carved, planed as wood, turned in a lathe, cut with a saw, stamped in a die, can be made either transparent or opaque, and besides these qualities, it is capable of bearing a high polish.

The interest taken in the invention from its exhibition at Paris became considerable, and the silver prize medal was awarded to the inventor. It was by some considered one of the most notable specialties of the Exhibition, and a company was formed in London to work it, into which Mr. Parkes, the inventor, threw all his rights and took common lot with the shareholders. From some cause or other the speculation was a failure, the company was dissolved, and the inventor was doomed to see the hope of many years destroyed at once—so far as he was concerned. The failure of the London company was understood to be principally due to their endeavor to make celluloid at too cheap a rate, and for that purpose the cheapest cotton waste and other articles were bought and used. It was considered to be the better plan for the company to commence making it by the ton, so that they might sell at the lowest possible price, which seems to have been a mistake; most of the material sold was sent out without due regard being paid to its being well seasoned; and besides these errors, there were other causes contributory to the ruin of the company, quite apart from the merits or otherwise of the invention. As we said, at the Paris Exhibition this invention, and the specimens of it, made quite a great sensation, and among the most earnest inquirers respecting it were many of "our American cousins." They asked endless questions about it, and from the information so obtained were sharp enough to make good use. The American Celluloid Company established, and still carry on, large works at Newark, New Jersey, where all the celluloid used in America is made. The New York *Post*, in a recent article on the subject, says of it:

"All the celluloid used in America is made by a single company, having factories at Newark, N. J., who sell the crude material to those in America engaged in the production of finished goods. No one can buy it unless the producing company decides to give him a license, which is granted only for the purpose of making some new article that will not interfere with the trade of the companies already licensed. A number of large corporations are now engaged in the various branches of manufacture for which celluloid can be employed. Most of these have their factories in Newark, but there is one large establishment in Centre street, New York.

"The cost of the crude article to the buyers is regulated by the producing company according to the use to be made of it and the competition met with in other materials. For instance, $4 or $5 per pound are charged for celluloid which is to be made into jewelry, while only $2 are charged if it is designed for umbrella handles, though there is no difference in the quality of the substance.

"As a close imitation of ivory, celluloid has made great inroads in the business of the ivory manufacturers. Its makers assert that in durability it is much superior to ivory, as it sustains hard knocks without injury, and is not discolored by age or use. Great quantities of it are used for piano and organ keys, to the manufacture of which one company is devoted. Billiard balls are made of celluloid at half the price of ivory, and are said to be equally elastic, while more durable. Large amounts are used for combs, for the backs of brushes and hand mirrors, and toilet articles; a fine-tooth comb made of celluloid is 25 per cent. cheaper than ivory, while in large pieces, such as the backs of hand glasses, the difference in price is enormous. Among many other articles in which celluloid takes the place of ivory or India-rubber are whip, cane, and umbrella handles, every kind of harness trimmings, foot rules, chessmen, and the handles of knives and forks. Its use in cutlery is said to be especially desirable, as it is not cracked or discolored by hot water. India-rubber, as a general rule, holds its ground against celluloid, as the latter cannot be sold so cheaply. The celluloid is said to be much more durable, however, and it is superior for pencil cases, jewelry, etc., where gold mountings are used, as it does not tarnish the metal, whereas the sulphur in India-rubber tarnishes gold of less than eighteen carats. The freedom of celluloid from sulphur, and the natural flesh color which can be imparted to it, have caused it to be extensively substituted for India-rubber in the manufacture of dental blanks, or the gums and other attachments of artificial teeth. Celluloid can be mottled so as to imitate the finest tortoise shell, and its elasticity renders it much less liable to breakage. In this form it is used, like the imitation ivory, for combs, card cases, cigar cases, match boxes, pocketbooks, napkin rings, jewelry, and all sorts of fancy articles. The substance is employed for similar purposes as a good imitation of malachite and also of amber. It is made into mouthpieces for pipes, cigar-holders, and musical instruments, and is used as the material of flutes, flageolets, and drumsticks. For drum-heads it is said to be superior to parchment, as it is not affected by moisture in the atmosphere. As a substitute for porcelain, celluloid is used for the heads of dolls, which can be hammered against a hard floor without danger of fracture. Beautiful jewelry is made of it in imitation of the most elaborately carved coral, reproducing all the shades of the genuine article.

"One of the large manufacturing companies is employed exclusively in the making of optical goods, using celluloid in place of tortoise shell, jet, etc., for the frames of spectacles, eyeglasses, and opera glasses. The material is extensively used for shoe tips, protecting the toes as well as metal tips, and having the appearance of patent leather. By shoemakers it is also used for insoles. Large quantities of thimbles are made of it, and it is said to be the best material known for emery wheels and knife-sharpeners. As a ground for paintings, celluloid has all the advantages of ivory, and photographs can be taken on it, which are alleged to be superior to ivorytypes.

"Within the last year and a half another branch of celluloid manufacture has been developed, which promises to reach enormous proportions. This is the use of celluloid as a substitute for linen or paper in the making of shirt cuffs, collars, etc. It has the appearance of well-starched linen, is sufficiently light and flexible, does not wrinkle, is not affected by perspiration, and can be worn for months without injury. It becomes soiled much less readily than linen, and, when dirty, is quickly cleaned by the application of a little soap and water with a sponge or rag. For travelers, and for wear in hot weather, this celluloid linen is especially convenient. It has lately been much improved by the introduction of real linen between two thicknesses of celluloid. Shirt fronts have been made of it, as well as cuffs and collars, and it is believed that these will prove equally desirable. Celluloid has been experimented with as a material for neckties, and although the trials have not yet been very satisfactory, it is thought that they will eventually be successful. For hat bands and hat sweat bands it is a trifle more expensive than the materials commonly used, but it is said to be better, as it does not become rusty or greasy. It has also been used lately for watch cases. There is a large export trade in celluloid articles to Cuba and South America, and this is constantly increasing. They are not sent to Europe, as the right to manufacture and sell them there has been sold to a foreign company, which has a factory in France."

The French Celluloid Company have established and are successfully carrying on large works for the same class of articles as are made of it in America, while "the unfortunate inventor"—to use his own words—"after devoting years of anxious and unremitting toil to the working out of the numerous difficulties attending the first introduction of such an entirely new material, fitted, from its great beauty and valuable properties, for an almost endless variety of uses—more, in fact, than any other substance at present known in the arts, has never received sufficient remuneration to reward him for the discovery and the expense of more than twenty patents, taken out by him in England and other countries connected with the manfacture of Parkesine, nitro-cellulose, celluloid, xylonite, American ivory, or any other fanciful name by which it is called."

I am glad to learn that Mr. Henry Parkes, who has generally, if not always, been associated with his brother, Alexander, in his inventions, has recently taken out two patents for improvements in Parkesine, or celluloid combinations, which bid fair to be, and it is to be hoped will be, both useful and profitable. It is pleasing to know that the further success of the invention, by which they may obtain some substantial return for their labor and skill, has not been given up by the Messrs. Parkes, and it is to be hoped that Birmingham, the place of its birth, may yet take the lead in carrying out this beautiful and important industry.—*J. R., in Design and Work.*

ELIQUATION OF ALLOYS.

WE have just had the pleasure of reading an admirable little brochure by M. F. de Jussieu, of the great printing firm of Jussieu & Son, of Antun, on the alloys of lead and antimony used in the manufacture of printing types in France. He observes that lead and antimony form several different alloys when combined in varying proportions, those generally employed in France containing—

	a	*b*	*c*
Lead	86·21	80	75
Antimony	13·79	20	25
	100·00	100	100

These alloys are prepared by throwing finely powdered regulus of antimony (pure metallic antimony) into melted lead that has been heated to a cherry red; the mixture is then well stirred together, and the combination takes place immediately the antimony is melted. In order to prevent oxidation, especially that of the antimony, which takes place with great rapidity at the temperature employed, it is better to sprinkle some powdered wood charcoal over the metals; or to throw into the pot a little tallow, which melts, and—decomposing on the surface of the molten metal—prevents

contact with the air, and reduces the oxide already formed.

PHYSICAL PROPERTIES.

Although solid at ordinary temperatures, the alloys of these two metals melt at about 690 deg. Fah. They can be heated almost to redness without volatilizing in the slightest degree. These alloys are soluble in melted lead, a fact which can easily be demonstrated by adding an excess of lead to the melted alloy; and then, from whatever part of the melting pot a sample of this metal be taken—whether from the top or bottom—the alloy will be found to be perfectly homogeneous.

The alloys of lead and antimony form rhomboidal crystals. To induce these crystals to form, the alloy is dissolved in melted lead, and then rapidly cooled. The alloy crystallizes, and through the phenomenon of eliquation, to which we shall presently more particularly direct our attention, the lead separates from the crystals formed by the alloy. By this means a spongy looking mass can be obtained, in which may be seen, by the aid of a magnifying glass, the crystals united on their planes of cleavage with very sharp angles.

The whole of the alloys formed by the combination of these two metals are capable of being tempered. To effect this the melted metal is poured into the typographic moulds, when the sudden decrease of temperature gives the casting a hardness that it does not possess if gradually cooled. But the tempering does not extend equally through the substance of the plate, being greatest at the surface and gradually diminishing, until at the center it is almost non-existent. The success of the tempering process is easily ascertained by cutting the surface with a chisel.

CHEMICAL PROPERTIES.

The constituent parts of these alloys never remain the same for any length of time; the action of prolonged heat, if only for some hours, decomposes them, and causes the formation of a new alloy richer in antimony than that decomposed. One consequence of this property is to free a certain proportion of lead, which is then in excess in the melted fluid, and the interesting phenomenon of eliquation then takes place, and often causes considerable anxiety and many failures to the workmen employed. We shall now briefly describe what we mean by eliquation.

When, through the decomposition of the alloy by the action of prolonged heat, the lead is thrown in excess, a mixture results which cannot be distinguished from the previous one by the eye of the workman. But, if he place a little of it in the mould, the granular and spongy appearance of the metallic plate shows at once that the metal has undergone a change. In fact, at the moment that the sudden chill takes place, the alloy first crystallizes and the more fusible lead leaves the crystals immediately they are formed. This is what is known to chemists by the name of eliquation, which takes place to a greater or less extent with all alloys, but most commonly with those of the two metals under consideration. This occurrence necessitates the casting a fresh plate, as the granular surface would not print a clear impression.

To stop the eliquation the alloy must be restored to its original composition, and the temperature of the melted metal lowered to the degree below which eliquation will not take place. This is usually done by partially cooling the furnace, and placing in the melting pot a fresh ingot of cold alloy, which in melting absorbs a good portion of the heat of the eliquescent metal.

M. de Jussieu says that in practice he has frequently found that when he has added to the mixture an ingot apparently amply sufficient—sometimes even one of as much as 101 lb. to a mass of 120 lb., it has had no effect whatever in preventing eliquation. On the other hand, sometimes a very small quantity, even a few ounces of added metal, sufficed to restore the alloy to its pristine state. He was for some time considerably exercised in mind thereby, until he ascertained by repeated experiments that in the first case the large ingot introduced was freshly made, and, not having cooled, had neither parted with its latent heat nor crystallized by slow cooling.

In the other case, the contrary was the fact; the few ounces of alloy had not been near the fire for some days, and, in consequence, were perfectly crystalline. They served as a nucleus of crystallization, which was set up in the melted metals immediately they were introduced. It appears that while this process of crystallization round the nucleus is proceeding a skilled eye at once notices the ripples caused on the surface, which apparently becomes pasty and granular, and no longer shows the glitter of the liquid metal. But as the temperature is raised the coagulation disappears, and the whole becomes liquid again under the action of the furnace.

In the circumstances just mentioned the cessation of the eliquation can be brought about by lowering the fire and stirring the melted metal until a crystal is formed at the edge of the melting pot. Immediately this takes place the alloy resumes its old composition, and crystallizes round the nucleus thus obtained. This operation, however, is longer and more difficult than the introduction into the pot of the crystalline nucleus ready formed, as we have described.

IDENTITY OF THESE PHENOMENA WITH SUPER-SATURATION.

These phenomena appear to us to reproduce very closely the super-saturation produced by, say, sulphate of soda dissolved in water. When a crystal is placed in the super-saturated liquid the mass coagulates round the crystalline nucleus. In the fluid metal we have the reduction of the super-antimonial alloy and the recomposition of the original alloy round the nucleus. These two phenomena, apparently distinct, are in reality identical; because, if the sulphate of soda dissolves in water, it is because molecular attraction exists between the salt and the water, the result of which is the formation of a hydrate—a real combination of the two substances. It is by reason of this molecular attraction that the super-saturated liquid solution remains at a temperature at which, under ordinary circumstances, the sulphate would not dissolve. When the crystalline nucleus is introduced, the hydrate decomposes and the freed salt crystallizes.

This is exactly what takes place in eliquation. There is a combination of all the antimony of the alloy with a lesser quantity of lead, a certain portion of the metal set at liberty; and then, by the introduction of the crystalline nucleus, the reduction of the super-antimonial alloy formed and the recomposition of the former. The only appreciable difference is that at the temperature of the operation on the alloys the metal remains liquid; while the sulphate of soda becomes solid again at the temperature at which super-saturation has been experimented upon.

These facts are a new and striking proof of the influence exercised by the intervention of physical forces in the production of chemical changes.

UNIVERSAL METHOD OF DETERMINING ARSENIC.

MILLOT AND MAGNEUNE treat the substance in which the arsenic has been detected with nitric acid. The filtered solution is evaporated to dryness, taken up in water acidulated with sulphuric acid, and introduced into a Marsh apparatus. The gases, which contain only arsenic and antimony, are passed into nitric acid, where they are oxidized. After about two hours the reaction is generally at an end, but it is well to ascertain this point by substituting for the delivering tube of the apparatus a tube drawn out to a fine point. The flame of the escaping hydrogen should not produce the well known spots upon porcelain. The nitric solution is evaporated to dryness and treated with water, which dissolves only the arsenic acid, leaving undissolved any antimony which may be present. In general the solution is precipitated with magnesia mixture, and the precipitate is weighed on the filter as ammonio-arseniate of magnesia. The authors, however, prefer the following method. They dissolve 100 grammes crystalline sodium acetate with 50 grammes acetic acid, and make up with water to a liter. Secondly, they dissolve 20 grammes uranic nitrate in one-half liter water, add a few drops of ammonia till precipitation begins, then add exactly as much acetic acid as is necessary, and make up with water to 1 liter. Thirdly, 100 grammes potassium ferrocyanide are dissolved in water to 1 liter. Fourthly, 5 grammes arsenious acid are dissolved in boiling nitric acid, evaporated to dryness, and dissolved in water to 1 liter. The last solution, which contains in 10 c.c. 0·0581 arsenic acid, serves to titrate the uranium solution. 10 c.c. of this normal solution of arsenic acid are mixed with water in a porcelain evaporating basin to about 1 deciliter, 10 c.c. of the sodium acetate solution are added, the whole brought to a boil, and the uranic solution is added drop by drop till the arsenic acid is completely precipitated as uranium arseniate. This is recognized by placing a drop of the boiling solution upon a plate and mixing it with a drop of the ferrocyanide solution, when a faint reddish coloration is produced. The volume of the uranic solution consumed is read off on the burette, 0·5 c.c. is deducted as a correction, and on dividing 0·0581 by the corrected number the contents of the solution per 1 c.c. is obtained. One c.c. of the uranic solution represents, therefore, 0·005 gramme arsenic acid. The same process is then repeated with the solution under examination. On multiplying the number of c.c. of the uranic solution, which are consumed by the value as above ascertained, the quantity of arsenic in the substance is obtained.—*Journal de Pharm. et de Chimie.*

DETERMINATION OF CHEMICAL AFFINITY IN TERMS OF ELECTRO-MOTIVE FORCE.

DR. C. W. WRIGHT, after giving a history of the subject, described his original experiments. These consisted in performing electrolysis of sulphuric acid and measuring the heat evolved in the process, and by recombustion of the materials. A voltameter with spade-shaped platinum electrodes, soldered to stout copper wires, and sealed by a large plug of gutta-percha, was employed for the electrolysis. An ordinary water calorimeter was used to measure the heat given off, as Bunsen's was found to contain sources of loss of heat. The strength of the current employed was varied from 6 webers to $\frac{1}{15}$ weber. The volume of gas produced was measured by Joule's plan. Radiation loss was corrected for by three methods. From an average of eighteen experiments the value of e, the electro-motive force, was found to be 1·5038 C.G.S. or volts. Taking the formula—

$$J = \frac{e}{(H + h)x},$$

where J is Joule's equivalent, H is the heat actively evolved, h the heat evolved by recomposition, and x a constant to which Kohlrausch gives the value 0·000105. Dr. Wright finds that Joule's equivalent should be $4{\cdot}196 \times 10^7$ instead of $4{\cdot}20 \times 10^7$ as given, to answer the formula. The author thinks that Joule's water friction experiments gave the truest value of J, and that his electric heating experiments gave a result about one-half per cent. too low, owing to the B. A. unit of resistance being about 2 per cent. too high and other causes.

BAROMETRICAL PRESSURE IN CONNECTION WITH FERMENTATION.

IT has been proved by Mr. Horace Brown that pressure has a material influence on fermentation; this investigator found that in addition to the well known products of fermentation, viz.: alcohol, carbonic acid, glycerine, and succinic acid, there were also evolved some gases, viz: hydrogen and nitrogen; he also found that with a reduction of pressure there was a diminution of nitrogen, but an increase of hydrogen, and further, he observed that at reduced pressures there was less sugar decomposed. It seems, therefore, that pressure is favorable to fermentation, and it becomes interesting to know whether the variations in barometrical pressure can have any influence on fermenting worts; three inches is perhaps the extreme variation of the barometer known at the ordinary levels of this country, and this is only equal to 1½ lb. on the square inch; such a difference can have but very little influence; it is, however, well for the practical brewer to recollect that increased barometrical pressure assists fermentation; it is also important to bear in mind that when atmospheric pressure is low, the bubbles of carbonic acid escape from the fermenting beer with greater facility, and this may often have something to do with the "head changes" to which some brewers attach so much importance.

COMPOSITION OF MAIZE.

THE following is an analysis of a sample of maize of average quality:

	Per Cent.
Water	17·1
Starch	59·0
Albumnioid matters	12·8
Fatty matters	7·0
Dextrine and sugar	1·5
Cellulose	1·5
Ash	1·1
	100·0

LEAD FROM TIN BY ACETIC ACID.—Dr. Ambühl finds that dilute acid readily extracts the lead from such alloys. Banca tin was found perfectly free from lead. English bar tin contains a slight trace.—*Schweiz. Wochensch. Pharm.*

ARTIFICIAL DIAMONDS.

THERE seems no reason to doubt that Mr. J. B. Hannay, of Glasgow, has succeeded in making artificial diamonds. Besides his preliminary note in the "Proceedings of the Royal Society," a long paper by himself and Mr. James Hogarth has been communicated to the society by Professor G. G. Stokes. The title of this paper will indicate the direction which Mr. Hannay's researches have taken; it is "On the Solubility of Solids in Gases." The writers conclude that the experiments described by them give a further proof of the perfect continuity of the liquid and gaseous states, and also a complete proof of the solubility of solids in gases. In the course of these experiments, made under pressures which sometimes reached 880 atmospheres, various substances were dissolved in gases and were crystallized out when the pressure was removed, and though nothing is said about artificial diamonds by the authors, it is understood that they were produced in the manner indicated. Mr. Allen, it will be remembered, recently spoke of the probability of these researches leading to the production of artificial diamonds.

PROFESSOR VOGEL has been experimenting with Dr. Eder's ferrous oxalate developer, and with the best results. He recommends the following formula:

A.—Neutral potassium oxalate	260	grammes.
Water	1,000	"
B.—Ferrous sulphate	100	"
Water	300	"
Sulphuric acid	2 to 4	drops.

These two solutions are kept in stock, and when the developing liquid is required for use, three volumes of solution A are mixed with one volume of B.

THE AUSTRIAN SOCIETY for the promotion of Chemical Industry offers a prize of 200 florins in gold for the best treatise on the action of light upon and the consequent destruction of the coloring matters of indigo, alizarin, and rosanilin, and upon the products generated. A prize of 100 florins in gold is offered for the best research on the peculiar coloring matter of jute, and with the object of discovering a process for its destruction without injury to the fiber.

ON TONGA: A REMEDY FOR NEURALGIA, USED BY THE NATIVES OF THE FIJI ISLANDS.

By SYDNEY RINGER, M.D., Professor of Medicine at University College, London; and WILLIAM MURRELL, M.D., M.R.C.P., Lecturer on Practical Physiology at the Westminster School of Medicine, and Assistant Physician to the Royal Hospital for Diseases of the Chest.

A FEW months ago Mr. Ryder, a gentleman residing in Fiji, placed this remedy in our hands with the following account: It has been used for several centuries by the aborigines of the Fiji Islands. A European, who married the daughter of a chief, learned the secret from his father-in-law, in whose family the knowledge of the composition of this remedy has been an heirloom for upwards of two hundred years. This European gave the drug to Mr. Ryder, who requested us to test its virtues.

This gentleman tells us that the remedy consists of parts of at least two plants, whose botanical relations, however, he does not know. He has returned to Fiji, and intends sending specimens of the plants, that we may learn their natural order, etc. The parts of the plants are broken up into a coarse powder, and then wrapped up in a cover of the inner bark of the cocoa-nut tree. Mr. Ryder gave us the following directions regarding its use: "The bundle, without being unfastened, to be steeped in half a tumbler of cold water for twenty minutes, then squeeze the liquid from the bundle back again into the tumbler, and take a claret glass of the infusion three times a day, about half an hour before each meal. Dry the bundle and hang it up in a dry place to prevent its getting mouldy. It will answer for twelve months."

Mr. Ryder sent a large packet of the powder to Messrs. Allen and Hanburys, of Plough Court, City, who have prepared a liquid extract, containing one part of the drug in one part of the extract. Of this Mr. Ryder recommends a drachm three times a day. He and his friends have tried the remedy extensively, and find it most successful. He finds that it generally cures by the second or third day. In eight or ten days the pain may return, when a few additional doses permanently remove the pain. It has been used in Sydney with great success.

We have used this remedy in eight cases of neuralgia; six were promptly cured; one was much improved; in the other, after a week's trial, it failed. We give a short account of these patients.

A woman, aged twenty-three, had suffered for fourteen days from severe neuralgia of the infra-orbital and great occipital nerve. She had four severe paroxysms in the day, lasting from half an hour to an hour and a half. Many of her teeth were bad. Three doses of the extract cured her.

A woman, aged about fifty-five, had suffered from severe neuralgia for a week. The twisting, dragging pain affected the supra-orbital branch of the fifth and the great occipital, and was both continuous and paroxysmal. She did not improve, though the infusion from a bag was used for a week. The bag had been used on several occasions, and possibly had become inert.

A woman suffered from neuralgia in the left great occipital nerve. Four half-drachm doses of the liquid extract cured her.

A man, aged twenty-five, had suffered for a fortnight from severe bilateral neuralgia in the temples, in the eyes, and under the eyes. Half a drachm dose of the liquid extract thrice daily cured him in three days.

A woman, aged twenty, for ten days had suffered from severe neuralgia in the first and third branch of the fifth nerve. She had daily about five paroxysms, each lasting from one to two hours. A drachm of the liquid extract thrice daily cured her in three days.

A girl, aged eighteen, suffered from toothache and severe neuralgia along the lower jaw, and in front and behind the ear. Half a drachm of the liquid extract cured the neuralgia in twenty-four hours, but the toothache continued.

A man, aged sixty, who suffered from rather severe bilateral orbital neuralgia, was greatly benefited in three days by a drachm of the extract thrice daily.

A woman, forty years old, had suffered for a month with about six severe paroxysms daily of pain in the second branch of the fifth nerve. The infusion made from a bag cured her in three days.

This remedy, whilst apparently highly useful in neuralgia,

produces no toxic symptoms, for we have given two half-ounce doses of the liquid extract at half an hour's interval, and repeated it again in two hours, without producing any effect beyond slight drowsiness. To another person we gave three two-drachm doses at half an hour's interval, and only produced slight drowsiness. These doses did not affect the pupil, nor increase nor lessen the secretion of the mouth or skin, neither did they affect sensation of the skin, supplied by the fifth nerve.

Tonga does not affect the pupil when topically applied to the eye; for Mr. Copley made observations on three people, and applied in each case an aqueous extract (1 in 1) to the eye, repeating the application four times at an interval of fifteen minutes, but the pupil remained unaltered.—*La ncet.*

PLANS FOR REDUCING OBESITY.

AMONG the complaints which are not maladies which the physician is at times called upon to treat, obesity is one which is frequent and troublesome. The remedies which have been suggested for it class themselves under three heads:

1. Diet. 2. Exercise. 3. Specific Medicines.

The diet plan is well known throughout the civilized world, by the pamphlet of Mr. Banting, of London, nearly one hundred thousand copies of which, if we recollect rightly, were published in the English language alone. The practical difficulties in carrying out his plan are that it cuts off the very articles most generally prized by fat people, and that it brings about in some constitutions a decided debility, and even certain forms of kidney disease. Nevertheless, we know several persons who have for years regulated their weight and prevented a natural tendency to lay on fat, with very little trouble, by a more or less rigid observance of Banting's rules.

Every one knows that sufficient exercise, hard, bodily labor, if you please, will certainly prevent obesity, and remove it when present. The first step in training for an athletic contest is to work off the fat, and there is never any difficulty about it in the hands of a skilled trainer with a willing pupil. But to many it is not at all a pleasant method, and to many more it is practically out of the question, because they have no time and no opportunity to take it up. We are, therefore, often driven to:

Specific Medicines. The question is, are there any? To begin, certain natural mineral waters have quite a reputation this way. This may seem singular, as a favorite plan to reduce fat, with the older physicians, was, as near as possible, absolute avoidance of all liquids. Thus Ettmüller, writing in 1685, says: "*In obesis remedium infallibile est abstinentia a nimio potu*" (*Opera* I., page 240). But these mineral waters, such as Marienbad, Montmirail, Andabre, etc., are more or less alkaline and laxative, and thus, it is believed, counteract the effect of the fluid itself. Best of all, probably, sea water.

Not long since, in a number of the *Paris Médicale*, there were some remarks on the treatment of obesity by the administration of sea water combined with a residence at the seaside. Sea water taken internally, it is stated, acts as a diuretic and purgative, particularly the latter. A small glassful of it should be taken three times a day in a little fresh water or milk. Sea-water baths are also to be resorted to, free exercise should be practiced, and fattening articles of food strictly avoided. It is stated that sea water used in this manner facilitates the oxygenation of the blood, and that it hastens the elimination of effete materials.

A sea weed, the *fucus vesiculosus*, has, of late years, been brought into notice as an attenuant. It contains iodine and bromine in small quantities, and was administered by Laennec, in phthisis, as a tonic. In some parts of Ireland it is used to fatten pigs, and even in famine times the peasantry have prepared it for food. That it could have, therefore, any attenuant properties must be held doubtful, particularly as the recent experiments with it have led to very conflicting results. Stillé, in the last edition of the National Dispensatory, dismisses it as quite obsolete for any such purpose. But Dr. Mulheron, of Detroit, thinks that much depends on the idiosyncrasy of the patient. According to him it is in the obesity of those of the lymphatic temperament that the beneficial effects of this drug are most marked. It has little or no influence in reducing the "fleshiness" of persons of active habits and of the sanguine temperament. In these, he adds, strict regulation of diet affords almost the only prospect of relief, but, owing to the keenness of the appetite which usually exists, this regulation can very rarely be enforced. The cases in whom *fucus vesiculosus* shows its most decided beneficial effects are women in whom there exists usually some menstrual derangement, as menorrhagia and leucorrhea, owing to an atonic and flabby condition of the uterine tissue. In such cases an improvement in these local derangements usually precedes the general reduction of fat and the improved tonicity of the general system.

Arsenic, in some cases, has been found effective by Dr. Whittaker, of Cincinnati. He thinks it may act in the reduction of fat, by simply increasing the absorption of oxygen gas, and thus securing its decomposition into carbonic acid gas and water after the usual way. For this remedy has long been administered empirically and with great efficacy in asthma and allied diseases attended with a diminished inhalation or absorption of oxygen gas.

Alkalies, pre-eminently the *liquor potassæ*, in full doses, are unquestionably successful in diminishing the weight; but the quantities required to accomplish this effectively are nearly sure to bring about alkaline dyspepsia of an intractable character, and a cachectic condition much more distressing than that of polysarcia.

Such are the alternatives before our fat friends. Perhaps the best advice we can give them is a judicious combination, in moderation, of all three of the agencies for reducing weight which we have enumerated. Taken together or in turn, one or all will be sure to lessen weight.—*Medical and Surgical Reporter.*

CURE OF DIARRHEA BY ICE WATER INJECTIONS.

DR. C. A. EWALD, of Berlin, states, in a recent monograph, that he has employed this plan of treatment for more than a year, in those forms of diarrhea, especially of children, which depend on some alteration of the colon. After each stool he injects from 200 to 300 c. c. of cold water, which is caused to run out again by slight pressure on the abdomen; then he injects 50 c. c. to be retained. The effect of this treatment is surprisingly good, and the mothers readily give their consent to it.

The author has only had the opportunity twice to make use of it in treating adults, but in both cases with equally good results. Whether this is due to the removal of irritating substances or to a diminution of peristaltic motion remains as yet unsettled. The author points out its great advantage in army practice—it costs nothing.

BEERS AND ALES, CONSIDERED MEDICALLY.

THE enormous and increasing consumption of what is known as "lager beer" in this country should attract the attention both of sanitarians and sociologists. Whether, as some claim, this must be hailed as an indication of improved drinking habits in the people, by the substitution of a light alcoholic drink in the place of distilled spirits; or whether, as another party maintains, it really indicates more widespread alcoholic indulgence, and offers but another step to make easy the *descensus Averni*, is matter for the sociologist to study. The qualities of the beverage and its effects on the constitution belong to medicine.

In England, what Americans call ale is known as beer; and the total consumption is estimated at 150 quarts per year per head of adult population! But this enormous quantity is distanced by Belgium, whose natives swallow an abominable sour stuff called *faro*, a beer fermented till the acetous elements are developed, to the extent of about 160 quarts per head; and is altogether left out of sight by Bavaria, the Paradise of beer swilling, whose inhabitants guzzle at the rate of nearly 300 quarts (to be accurate, 289 liters) per adult per year! The total annual production in the United States is estimated at over 300,000,000 gallons annually, an enormous increase within the last twenty years. This includes what are termed ales, porter, and brown stout, as well as beer. The price at wholesale is from five to eight dollars a barrel.

Theoretically, these beverages are produced from barley, malt, hops, and pure water, and nothing else. From two to three bushels of malt and as many pounds of hops are allowed to a barrel, and the liquor should have five to eight per cent. of alcohol, according to age. And when made in this way, carefully fermented, and properly kept, such a beverage would be as unobjectionable as any that could be named holding alcohol as a constituent.

In point of fact, however, very little such malt liquor is to be had. There are chemical manufacturers in this country whose principal business consists in supplying artificial substitutes for the genuine components of these drinks, and also means of correcting, adulterating, coloring, and remaking, as it were, spoiled and fraudulent articles.

It is well known that the principal use of *glycerine* is now by the breweries. It is added to impart smoothness to the fluid, to give it a fine froth or "bead" when drawn, and to conceal the taste of certain adulterants. Instead of hops, what is known to the trade as "hop substitute" is used, which is a bitter vegetable bark, finely chopped, and often combined with aloes. Picrotoxin and strychnia are probably never employed. To give a crisp, dry flavor, esteemed by some, tannate of sodium is added; to impart a bright brown hue, preparations said to be made from burnt sugar are sold; liquid isinglass, to add the esteemed "creaminess;" and so on. Then there are various materials to bring up a spoiled brewing to the proper marketable character—bisulphite of sodium, "ale finings," "porterine," etc., the results of applied chemistry in this questionable department of science.

Whether the consumption of such stuff is likely to benefit the drinker, especially when taken in large quantities for a length of time, is open to serious doubt. It has been said by European observers that chronic alcoholism from beer is one of the most hopeless forms; that the mental faculties are debilitated and the reaction of the system slight. It would be well for surgeons in our large municipal hospitals to examine into the relative power of endurance of beer drinkers and others.

We have seen no analysis of American beers; they have been exempt from such inquiries. We add, therefore, the plan pursued by Dr. Enders, a German chemist. He mixes one liter of beer, in an evaporating dish, with ten grammes of fine granular animal charcoal, evaporates the mixture to dryness on a water bath, stirring occasionally, treats the residue, after cooling, with cold water, until the filtrate passes colorless, and then extracts the charcoal with hot alcohol, which dissolves all bitter principles and alkaloids; these may afterward be readily determined by their respective tests. The charcoal contains, besides the bitter principles, only a coloring matter.

One thing is clear; that physicians who recommend beer or ale to patients should make themselves sure that they are not thereby leading them to the consumption of stuff more perilous than the diseases the stimulant is intended to combat.—*Med. and Surg. Reporter.*

EFFECTS OF THIRST.

To the Editor of the Scientific American:

I was interested in an account which appeared in the SCIENTIFIC AMERICAN, June 8, 1878, of the sufferings of a party of troops in New Mexico. This has induced me to give an account of my own sufferings experienced in a journey in Central Australia, in 1864, when I was about twenty-four years of age. I think it would be interesting to your many readers, because I look upon my case as very exceptional, to have come out alive from so severe an ordeal.

I started alone on horseback over the stony plains, in the vicinity of Lake Gardiner, which are used as a sheep pasturage in more favorable seasons. I had traveled the route many years before, but in a more humid period. The climate of this part of Australia is somewhat like that of the waterless arid regions of New Mexico, Arizona, and Lower California. It was in the middle of summer, and the days were dreadfully hot. There was no grass or herbage then, and the sheep runs had been abandoned for want of grass and water, and the sun shone down upon the smooth, glassy stones with a glare and a recoil that were extremely irritating to the eyes, almost similar to what one experiences in snow blindness.

It certainly was a hazardous undertaking, and as I look back now in more mature years, I think it a very foolhardy one. It was undertaken to save me a distance of a hundred miles' travel. I took with me a canteen of water beside my usual kit, traveled thirty miles till sunset, arriving at a lagoon which I had always supposed was a permanent water. It was all dried up, and its bottom was incrusted with salt or alkali. There was a pint of water in my canteen, which was divided between myself and horse. I let out my horse here to graze on whatever he could pick up, and I ate a little dry bread and meat, quantity limited, as it had become so dried during the day that I could not swallow it.

An irresistible drowsiness then came over me, and I slept till midnight with the saddle for my pillow, when I was awakened by a cold chill which I felt as being very sharp and stinging, like the sensation one feels in the cold fits in fever and ague.

Restless till daylight, when I started on my journey. Would not turn back. Felt sure of finding water in twenty miles, either at another lagoon or at a well. After sunrise commenced to feel the pangs of thirst, my horse hanging down his head nearly to the ground, though going along pluckily.

Toward evening suffered much. My tongue and lips began to stick together, though I was chewing a couple of small pebbles, said to be an incentive to bring moisture to the mouth. Time seemed to be very long over those weary, cheerless plains, and imagination led me to the belief that the sun stood for hours in the one spot.

A flaring mirage had sprung up about noon on the horizon, and continued all the afternoon, inciting me to the hope that it was a lake of water in the distance, though I knew quite well that no lake existed in that direction. Obliged to rest several times from sheer exhaustion. My skin began to dry and shrivel up. Horse's tongue swollen and standing out beyond his teeth. He was an aged horse, in good condition, and had stood many lesser trials before. My eyesight (usually farseeing) began to fail, and it sometimes seemed to me as if the plain was rolling and heaving in waves like the billows of the sea.

Came to the lagoon, formerly a mile long and wide. There was a few yards of shallow water in the center, probably salt then, which could not possibly be got at for bog and mud. Rested. Sick at heart. Sick at stomach, but could not vomit. Drove my horse before me to the well, two miles. Found the place abandoned—rope, bucket, and all gone.

Sunset. Dropped a stone into well and, noting time of descent, judged it to be 140 feet deep. Passed a dreadful night; no sleep; horse groaning pitifully; scenes of youth rushing into my mind all night with an uncontrollable feeling of the last hours come. An idea struck me during night to kill the horse and make a rope of his hide. At daylight turned over everything, and could not find pocket-knife. Had lost it. Could find no substitute better than the handle of a pot, so had to give up that idea in despair.

Managed to swallow a few mouthfuls of meat and sugar. Kept on my journey till midday, driving horse before me, when I had to rest in the shade of a rock, suffering from vertigo and dimness of sight. Horse lying down, not caring to eat what little could be found, ever and anon lifting his head and looking forward. Rested six hours. Tried meat and sugar again, but could neither chew nor swallow any. Intended to open horse's vein and drink his hot blood, but could find no instrument to do it with. Tried for urine to mix with the sugar; none to be had. Intended, at this stage, to kill the horse by beating his head in with a rock, but could not do it as I was fond of the animal.

Cool of evening started on again, getting very weak. Progress very slow. Delirium seemed to be setting in. There was a constant ringing in my ears, like as of locusts chirruping; tongue very much swollen; an irrepressible desire of the eyelids to close. Traveled till midnight and in the twilight of darkness. There always seemed to be a dog at one side of me some twenty yards off, as also a bird like an owl flying overhead. I cannot now say whether they were real or imaginary, as everything at this stage seemed in a confused haze to me. Went to rest; could not sleep, but seemed to dream, with half-closed eyes, of grapes and delicious fruits and banqueting generally.

At daylight, saw the hills a few miles off where I knew there was water, but felt no inclination to make an effort to get there. From this time to the time that I took the first draught of beautiful spring water in the hills I have no recollection whatever, nor do I know what became of my horse until some time after, when I discovered his skeleton. Neither do I know how long it took me to get over those three or four miles, whether two hours or forty, or whether I went straight or roundabout. My senses came to me when I drank water. My body was like a skeleton, though I was in full flesh four days previous. My skin was shrivelled up. My nose was stopped up with dust. I could not swallow water but with great difficulty, the tongue being so swollen. I retained my traveling kit during the delirium, which was fortunate.

After the first draught or two, I drank moderately, with a little sugar. I never vomited any. I drank about half a gill every few minutes for about twenty-six hours, when my thirst first gave signs of being satisfied. I think that I drank about a quart per hour during this period. The most strange part of this matter was, and which like I have never seen recorded before, was that, although I drank this very large quantity of water, no urine passed from me for about thirty-six hours after I drank the first draught. The water seemed to distribute throughout the body.

In this connection, it would have been very interesting to know what was my weight when I first arrived at the water and forty hours after.

From the foregoing it will be seen that I was seventy hours since the last drop in the canteen—perhaps ninety hours, as I cannot say what time passed during delirium, and had not noted of late either the date or day of week. During the thirty-six hours after coming to water, I felt myself the subject of convalescence and torpidity, with a soothing sense of gratitude, mingled with fits of sorrow for loss of horse, an animal for which I had formed an attachment. As soon as my thirst had been satisfied, I became hungry, eating what I had left. Then, filling my canteen, I started across the hills, and reached a human habitation late in the day.

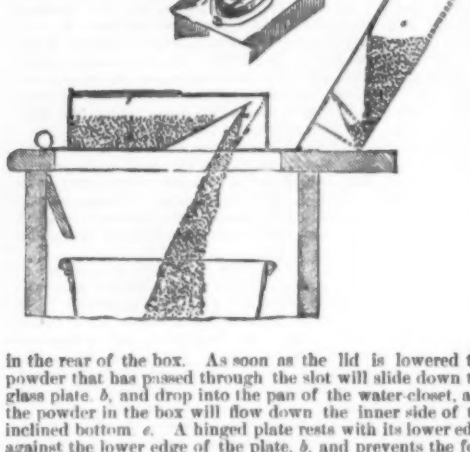
Concerning the delirium recorded in the above adventure, the question has often occurred to me, "Is man possessed of instinct when bereft of reason?" In this case, it certainly does seem as if he were, unless it can be shown that a man can lose his memory of recent events and still be sane. I have never seen that topic written about or discussed in print, and that is the reason I have introduced it here. The somnambulist, for instance, cannot be said to be insane, and yet has no memory; but the somnambulist's delirium (if such it can be called) was different to that which occurred to me. And what shall we say of the drunkard? Has instinct ever been exhibited in his delirium? If it was not instinct that led me to water (locality known to me in years previous), what was it? Or can reason and sanity exist and be active without memory? Some of your readers may attempt to explain it in habit, as, for instance, the habit of a horse who will walk unerringly in his usual horse track after he has become blind; but this cannot scarcely apply to my case, as I had only a general notion of the configuration of the locality such as any man can only have who has traveled but once over a locality many years before. The subject is one that, I presume, very rarely occurs; and when it does, it is generally under such circumstances that no scientist is at hand to note the aspects of the case.

J. E. RICHTER.

AUTOMATIC DISINFECTING APPARATUS.

THIS apparatus consists of a box, in the shape of a water-closet lid, and is hinged to the seat. It is provided with a slide, *f*, which closes the opening in the top of the box, through which it is filled with some disinfecting powder.

The bottom of the box is inclined upward toward the rear side of the same, so that a narrow slot is formed between the upper edge of the inclined part, *e*, of the bottom and the top of the box. If the lid is raised, as shown by dotted lines, the powder will flow through the slot and rest in a corner formed by the top and an inclined glass plate, *b*,



in the rear of the box. As soon as the lid is lowered the powder that has passed through the slot will slide down the glass plate, *b*, and drop into the pan of the water-closet, and the powder in the box will flow down the inner side of the inclined bottom *e*. A hinged plate rests with its lower edge against the lower edge of the plate, *b*, and prevents the foul gases or moisture from passing into the box. This hinged plate is raised by the powder that glides down the inclined plate, *b*, but is closed by its own weight as soon as the powder has passed.—*Neueste Erfindungen und Erfahrungen.*

CITY SCAVENGING AT BOSTON.*

By E. C. CLARKE, C.E.

THE subject of sewerage having been elsewhere fully discussed, it is proposed to treat of the removal of such material as must be carried away, and to tell how much work is done in Boston.

The work devolves upon a committee of five members of the City Council chosen annually; they control the expenditure of the appropriation annually made.

The superintendent of the work, however, is appointed by the Board of Health and approved by the Mayor. The Board can request that the scavenging shall be done to its satisfaction. Notwithstanding the frequent changes in the personnel of the Board of Health, city physician, superintendent, etc., the system has been found in the main to work well. The secret of this is that very few changes are made in the superintendent and those who do the work. All the men employed are fitted by long training for the performance of their duty—all the foremen have been promoted from subordinate positions—few of the laborers have been employed less than five, many have served for twenty, and some for thirty or forty years. The permanence of the employment makes the places on the force to be eagerly sought for, and insures good conduct on the part of the laborers—which is further encouraged by the prospect of promotion, and also by the fact that it is the custom with families to give a gratuity at Christmas to those who have served them for years.

Scavenging includes removal of house effects—removal of ashes and dry house dirt, cleaning of streets and street catch basins, and cleaning of privy vaults and cess pools; for each of these a special and separate provision is made. Offal, meaning refuse food and matter known as swill, is taken daily from hotels, restaurants, etc., and two or three times a week from dwellings by wagons, each having a driver and helper. The wagons are built by the city, are water tight, and covered by a wooden lid. They start out at 4 A.M., first visiting hotels and restaurants; after 7 o'clock dwellings are visited. The driver rings at the yard gate or basement door, goes to the swill tub, empties its contents into his buckets, replaces the tub, and leaves the house. Should no effects be found, it is assumed that it has been improperly disposed of, and the matter is reported and investigated.

The wagon, when filled, is driven to the department depot, emptied upon a raised platform, and thoroughly washed and scrubbed before making another trip. There is no trouble in getting rid of the material. Regular customers come daily and take it away. The wagons of these parties are numbered and licensed, made water tight, and the owners made responsible for damage from leakage and other offense. The wagons are also of known capacity, and the material is *paid for* at the rate of five to seven dollars a cord. The sales of last year amounted to about $28,000. The cost of collecting and removal was $76,000. Ninety-six men and forty-five wagons were employed. In sparsely settled suburbs permission is given to private parties to use their own swill for feeding hogs, but the superintendent uses his own discretion in such cases.

Ashes are removed in carts built by the city. Hotels, stores, and tenement houses are visited twice a week, dwelling houses once a week; 117 men and 58 carts are employed; with each cart go a driver and helper, who enter the house or yard, carry out the ash receiver, empty it into the cart, and return it to its place. Men are not required to go up stairs; ashes must be brought to them at the ground floor.

It is worth noting that no stealing results from this visitation of dwellings. The men are so well known that they are on good terms with the citizens whom they visit; but one complaint of anything being stolen has been made in twenty years. The carts, canvas covered, when filled are taken to the nearest dumping ground.

It is hardly possible to find a place for dumping ashes which is free from objection. It is unfit for filling, because always mixed with miscellaneous household rubbish, dead rats and mice, etc. The ashes and house dirt are used to grade streets and parks belonging to the city, also private lands, when desired or permitted by the owner. This is unsatisfactory, for the reason that years afterward when trenches are dug for gas or water pipes, it is found that decomposition is still going on; where it is used for filling open squares and pleasure grounds no harm results, because, to support vegetation, it must be covered with good earth, and the trees and plants thrive upon the products of decay. But to dump house dirt upon land upon which houses are to be built is a serious evil.

The larger animals which die upon the streets are removed by a contractor for the privilege of possessing the carcass. The police notify the contractor, who dispatches a cart and removes the body—takes it to an island in the harbor, where every vestige of it is utilized. The business pays well, but the process is very offensive, and the stench is sometimes carried by certain winds three miles to the city. The cost of removing ashes and house dirt last year was $97,000.

In street cleaning, 185 miles of streets are swept and cleaned every week; those most frequented, daily; others, twice a week. Macadamized streets are not swept; they merely have their gutters cleaned and rubbish raked up and removed. Street cleaning, and all other work of the Health Department, is done by daylight. Night work has been found to be neither efficient nor economical. Both sweeping machines and hand labor and birch brooms are used in street sweeping—a one-horse machine, with revolving brush, does the work of eight men, and much more cheaply, but will not clean corners and depressions as a broom can. 48,000 cart loads of dirt, each 40 cubic feet, were collected last year, and disposed of in the same manner as the ashes and house dirt. It is rarely that it has enough value as a manure to be found salable. 170 men are employed in street cleaning. In winter, when the streets are covered with snow and ice, the force is employed in cleaning crossings, and removing snow from city sidewalks and grounds, while the carts assist in the work of carting away ashes, of which there is so much more to do at that season. During last year the cost of street cleaning was $83,000.

Street catch basins, connecting with the sewers, are built by the Sewer Department, but are cleaned by the Health Department; 43 men and 14 wagons are employed upon this work. The basins near the foot of hills generally need cleaning after every heavy rain; for those on level ground once a year suffices. The material removed is taken to a dumping ground and covered with ashes. Eight thousand eight hundred loads of this matter was collected last year, at a cost of $13,000.

Privies and cesspools, five or six thousand of them, are cleaned by a contractor, under the supervision of the Board of Health, at the expense of the householders. Contractors charge from $6 to $8 per load of 80 cubic feet, and are required to use patent odorless excavators. The machines, air-tight, have the air pumped out of them, and suck the contents of the vault, for any distance up to 125 feet, through a strong hose. A small charcoal furnace, connected with the air-pump, destroys any offensive gases. The work is done in the daytime without offense. The material is either taken in scows and dumped in the sea outside the harbor, or carted into the country and buried in pits. Not one load in ten can be sold for manure. So far from its having any manurial value, the city has to pay $6 a load to have it carted away, when Peruvian guano is selling at $50 a ton.

The sewerage of Boston is good, because it is well paid for—$340,000 being paid with a population of 360,000. The appropriations are controlled by men of experience who are outside of politics.

The laborers do their work well because they are well used to it, and know that fidelity insures permanent employment and probable promotion.

1. It may be said that removal and disposal of offal is satisfactorily performed.

2. The removal of ashes, house dirt, street sweepings, and catch basin sludge, is satisfactory, but the disposition of these is not so.

3. Certain portions of city scavengering may be done by contractors, under careful and strict regulation.

* From a paper lately read before the American Public Health Association.

ON THE PHYSICAL CONFIGURATION OF MARS.

By PROFESSOR WM. HARKNESS, U. S. Navy.

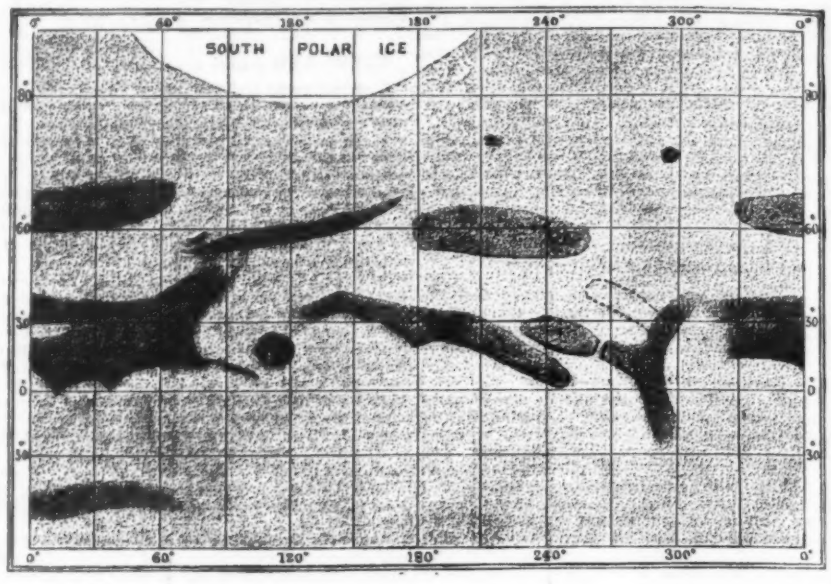
(Communicated by authority of Rear-Admiral John Rodgers, U. S. Navy, Superintendent U. S. Naval Observatory.)

I HAVE constructed the accompanying map of Mars from eight sketches taken by myself between August 18 and October 18, 1877. More sketches would have been exceedingly desirable, but the unsteady state of the atmosphere prevailing during the opposition rendered it impossible to obtain them. The telescope employed was the 26-inch Equatorial of this observatory. Eye-pieces magnifying up to 400 diameters were tried each night, but it was usually found that a power of 1[illegible]5 gave the best result. This was due partly to the southern declination of the planet, and partly to the bad seeing before mentioned. After each sketch was finished, Professor Hall very kindly compared it with the planet, and in every case he agreed that the sketch showed all that was certainly visible upon the planet, and nothing more. As seen through the telescope, the color of Mars was a golden yellow; except the polar spot, which was pure white, and the markings, which were a light indigo blue.

When laid down upon Mercator's projection the several sketches agreed well with each other, and resulted in the accompanying map; the latitudes and longitudes of which depend upon the Ephemeris given by Mr. Marth in the Royal Astronomical Society's *Monthly Notices* for April, 1877, vol. xxxvii., pp. 301-304. The features indicated upon the map by dotted lines were seen only once, and appear inconsistent with other features which were seen oftener. The south polar spot was sensibly circular in form, and, according to my sketches, had a diameter of about 14½°. Professor Hall determined the position of its center to be latitude 84·8° south; longitude 118° west

Owing to the meagerness of the data upon which it is based, this map cannot be regarded as complete; but it is hoped that it may be greatly improved during the opposition of next autumn. In its present state it somewhat resembles the map given by Dr. Kaiser in the third volume of the *Leiden Observations*.—U. S. Naval Observatory, Washington, June 17, 1879.—*Monthly Notes R. A. Soc.*

CHART OF MARS ON MERCATOR'S PROJECTION.



TOTAL SOLAR ECLIPSES.

IN view of the interest attaching to the question of an intra-mercurial planet, *Nature* enumerates all the total eclipses of the sun that will occur during the present decade. The first is the eclipse of May 17, 1882, in which the central line of totality passes over Egypt, not far from Luxor, near Teheran, and so across Asia to Shanghai. The greatest duration of totality is 1′ 48″, but at the most accessible stations will not exceed 1′ 15″. Then follows the eclipse of 1883, May 6, in which the course of the central line is wholly in the Pacific Ocean, avoiding apparently, with the exception of the Marquesas, the inhabited islands. It is probable, however, that the total phase may be observable at Channel Island, in that group, where it will begin about 42′ after noon, local time, and continue 2′ 52″. The eclipse of September 9, 1885, may be well observed in New Zealand, where the sun will be from 15° to 16° above the horizon. The duration of totality on the central line in the longitude of Wellington will be 1′ 54″.

Next follows the great eclipse of August 29, 1886, a recurrence of that of August 17, 1868, which was observed in India. Unfortunately, in this case, the line of totality is again an ocean track, excepting near the beginning and end of its course. At the southern extremity of the Island of Granada the sun will be hidden for 3′ 15″ while at an altitude of about 20°. In about longitude 14° 13′ west of Greenwich, and latitude 2° 58′ N., where the sun is centrally eclipsed on the meridian, totality will continue for nearly 6′ 30″, and it may be expected that efforts will be made to secure in this part of the Atlantic, at least, such observations as bear upon the existence of an intra-mercurial planet or planets. When the central line reaches the African coast, in 12° S. latitude, the duration of the total phase will be diminished to about 4′ 45″. The next eclipse is that of August 19, 1887, which it was supposed would be total in England. The central line begins, however, in Germany, in longitude 11° 39′ east of Greenwich, and latitude 51° 28′ North. It passes by Berlin and Moscow to a point in longitude 102° 15′ East, and latitude 55° 46′ N., where the sun will be totally eclipsed on the meridian, and thence to 173° 47′ East longitude, and 24° 3′ N. latitude, where the central phase passes off the earth. At Berlin, where the sun will only just be clear of the eastern horizon, totality lasts 1′ 41″, and in the longitude of Moscow, to the north of the city, 2′ 30″, with the sun at an altitude of 17°. On the shores of Lake Baikal, where the sun will be near the meridian, the duration of totality will be 3′ 38″.

The last total eclipse of the decade will take place on December 22, 1889. It may be observed at Bridgetown, Barbadoes, where the sun, at an altitude of about 6°, will be hidden for 1′ 48″. At a point on the Angola coast in about 10° south latitude, the totality will last 3′ 34″. The line of totality passes off the earth in longitude 60° 55′ east of Greenwich, and latitude 6° 53″ north.

SUCCESS.

1. "Practical success in life depends more upon physical health than is generally supposed."

2. "The success of even professional men depends, in no slight degree, on their physical health."

3. "The greatness of our great men is quite as much a bodily as a mental one."

MICROSCOPY.

HALL OF THE ACADEMY OF NATURAL SCIENCES.

Biological and Microscopical Section.

PHILADELPHIA, Feb. 2, 1880.

DR. CARL SEILER in the chair.

In answer to questions from some of the members, Dr. Seiler gave in detail the reasons why the lamp in illuminating objects should be placed to the left and below the level of the stage of the microscope. He said in order to manipulate the various parts of the instrument the right hand is employed, and, therefore, the lamp would be in the way if placed on that side. If placed higher than the stage the light would fall directly upon the object, and thus produce a confused image resulting from the mixture of transmitted and reflected light.

He further advised the use of both eyes alternately and together when a monocular instrument is used. If one eye alone is constantly made use of it becomes strained and is injured, and it is, therefore, better to employ both eyes alternately. In making drawings or measurements with the camera lucida it is necessary to use both eyes at once, and the student will find it difficult to keep both eyes open when he has at first accustomed himself to keep one closed.

The subject for discussion,

THE PREPARATION OF MATERIAL FOR MICROSCOPICAL EXAMINATION,

was introduced by Dr. Seiler.

He began by saying

The first step usually in preparing an object is to make it transparent.

To examine an object, such as a piece of flesh containing trichinæ, for instance, the simplest plan would be to tease a small portion with needles, and then examine it in glycerine. But if there are but few of the animals, we may be obliged to prepare many specimens before finding any.

Again, the multipolar cells of the spinal cord may be prepared for examination by very carefully teasing them, and washing away from beneath the cover glass the little particles which adhere.

The better and more satisfactory method, however, for attaining the object desired, is to make thin sections of the tissue to be examined, which may be done by first hardening the tissue and then slicing it by means of a sharp razor-like knife.

The usual methods of preserving and hardening objects so that sections thin enough for examination may be made were each considered.

Muller's fluid, chromic acid, alcohol, picric and osmic acids, the lecturer said, were usually employed for this purpose, and he gave an explanation of the action of these reagents upon the tissues of animals:

1. They preserve objects by excluding or killing all living organisms.

2. They harden by coagulating the albumen and gelatin, and by abstracting the water.

All these reagents cause, more or less, shrinkage of the specimen, and as this does not take place in a certain ratio, considerable distortion of the object is produced.

This may be overcome to a great extent by performing the operation of hardening slowly and gradually, in other words, by allowing the reagent to take the place of the water gradually. We therefore begin with the weak solutions, and by frequent renewals reach the strong.

Strong glycerine which abstracts water rapidly must, therefore, be the least desirable medium unless used with care, that is, by passing the tissue or section of tissue through several changes of different proportions of glycerine and water before it is placed in the strong glycerine.

The process of freezing fresh tissues for making sections was then considered, and its advantages and disadvantages were dwelt upon. Among the latter was mentioned the fact that the sections must first be immersed in either alcohol or glycerine before they will take the stain, thereby increasing the danger of shrinkage of the elements.

The proper degree of hardening is reached when the material taken between the fingers has the consistence and feel of a piece of soap. When it feels like rubber it is unfit for cutting, owing to the fact that it will bulge before the edge of the knife and an uneven and thick section will result.

Cutting sections by free hand is not as well done as by means of an instrument called a microtome, several forms of which were described. The doctor recommends from personal experience an embedding material composed of two parts of paraffine and one of mutton tallow. The mixture is then melted and allowed to cool to such a degree that it will just flow, when it may be poured around the piece of tissue to be embedded.

After the sections are cut the next step is to stain them in order to differentiate by means of color the different histological elements.

The different degrees of staining are governed by the age of the part.

Staining is usually accomplished by means of an alkaline solution of carmine, preferably prepared by dissolving carmine in a solution of borax. In this the sections are immersed for a shorter or longer period, and any excess of color is afterwards removed by either a tolerably strong oxalic or hydrochloric acid solution in alcohol or water.

The manner of staining with hematoxylin was described, and a late process of modifying the color by means of platinum bichloride was mentioned

The processes of double staining were then explained, and among them were mentioned the picro-carmine process, which produces red and yellow colors, not pleasing to the eye, and therefore objectionable except in some instances;

And the indigo and carmine process. This latter gives beautiful results, at once pleasing to the eye and valuable as means of differentiating structures which could otherwise not be recognized. The colors obtained by this process are a red and blue, the latter showing all different gradations of color between the emerald green to the indigo violet. It is preferable to stain first with carmine and then with indigo instead of a combination of the two coloring agents, because the process of staining can be better watched and stopped when completed. After the section has been stained it must be immersed in alcohol, if it is to be mounted in balsam or a resinous medium; or in glycerine, if to be mounted in the latter. Great care should be exercised in this part of the proceedings so as not to shrink the tissues, and both the alcohol and the glycerine should be increased in strength gradually.

At the close of Dr. Seiler's remarks, Dr. J. G. Richardson referred to the assertion made by Dr. Beale, and repeated in his last work, that preparations hardened in alcohol are of little use.

Dr. Seiler said that the objection of Dr. Beale was an old one, but that Dr. Woodward, of Washington, as well as himself, had thoroughly tested the relative merits of both alcohol and glycerine, and had reached the conclusion that the former is far preferable in most cases.

Mr. Ryder called the attention of the members of the section to some peculiar cells, apparently oil sacs, in the common limpet.

Mr. Potts exhibited and described a specimen of actinospherium, upon which he made some observations in regard to the spines. Instead of standing out in the usual manner, they were bent and curved over, showing that they were silicious.

In further examining in digest a small animal, he thought the body was ruptured, but on observing closely the particles of protoplasm were retracted and the spines become straight and normal.

RAISING TURKEYS.

I DO not flatter myself that I am competent to give the very best method, says a correspondent of the *Country Gentleman*, but knowing that I have had great success, my experience may not be altogether valueless.

First, select in the fall of the year the very best young hens you have in your flock—say five or six—and if they will roost outside the hennery during winter, so much the better. Do not be afraid that cold weather will hurt a full-grown turkey, for it will not, provided you feed them all the corn they will eat just before going to roost. Half-grown turkeys are sure to contract roup, whether roosting in doors or out during the winter, and even full grown ones frequently do if they are confined with the fowls in the hennery. I advise selecting young hens, for the reason that they are not as prone to hide their nests as old ones, and consequently you avoid a great deal of perplexity, if not loss, for skunks, foxes, and crows are great foragers on eggs. Place in the corners of the fences and the yards where the turkeys frequent, a few old pieces of boards set on end, and put a little straw or leaves behind, with an egg half secreted among the leaves, or in the straw. By so doing, you will surely decoy your turkeys into laying in the nests and places you have thus prepared for them. You will get from twelve to eighteen eggs each from your turkeys before they will manifest any inclination for hatching, and as soon as they remain on their nest over night, catch and lock them in a coop in the yard, where the remainder of the flock frequents, and about the fourth day you may let them out to roam at pleasure, and in about five or six days after they receive their liberty, they will commence laying again.

All the first lot of eggs received I place under hens for hatching, and you will find that the turkeys will have finished their second laying a few days before the hens have finished hatching. I then take the eggs from the hens and give them to the turkeys, and sometimes the turkey has only to sit a few days before she has her young. If I am compelled to leave some of the eggs with the fowls to bring out, I deem it an indispensable requisite to see to it that the hen is perfectly free from lice, using pulverized sulphur, etc., freely. I regard it as next to impossible for hens to raise young turkeys, for turkeys are exceedingly tender when young, and above all things they must be kept free from the parasites that infest the common fowl. They must not even be allowed to remain over night about the same building where the common chickens are kept. Do not be afraid of putting as many as forty or fifty young turkeys with the old mother turkey, but keep them in a dry, warm place, especially over night.

The feed must consist of boiled eggs, cut up very fine and mixed with bread crumbs and sweet milk—for a few days at least, gradually withdrawing the eggs and substituting therefor sour-milk cheese, with plenty of stale bread crumbs—finally substituting wheat bran and corn meal, well scalded, with the cheese. Under no circumstances give raw corn meal.

Turkey eggs that cannot be hatched before July 1 should rather be eaten than to attempt to hatch and rear young turkeys therefrom. In this climate such late chicks will not pay for the trouble. But in case a hen steals her nest, and brings out a brood at this season, do not feed them at all; they will get all the insects necessary, and in nine cases out of ten she will raise more from the brood by roaming at large than in any other way. By adopting the above method, the different mother turkeys will be acquainted with one another, and there will be no fighting among the old hens, thereby trampling and killing the young unintentionally.

Then, again, they will all associate and run in one drove, so that when brought up at night (as they must be), you will have no trouble in hunting up as many lots as you have mother turkeys. In no case allow your young turkeys to remain out in a thunder and rain storm, but it must be some person's business to see that they are all under cover before the storm begins. If there should be a cold rain storm, lasting for a day or two, be sure and mix with your feed some black or cayenne pepper.

I would not advise confining the young, except for a day or two until they become strong, then let them roam in a lot of two or three acres in a nice sunny place if possible, and be sure and feed regularly and frequently at first. For fattening give your turkeys boiled potatoes and corn meal, mashed together, until about ten days before you intend killing, then substitute boiled carrots for the potatoes, mixed with the meal, and my word for it you will have as fine looking a lot of turkeys as you may wish to see.—*C. L. G. B., Slingerlands, N. Y.*

THE EDIBLE FLOWERS OF THE MHOWA TREE.

MR. VALENTINE BALL, in his recently-published book, "Jungle Life in India," gives the following description of the uses made in India of the flowers of the mhowa tree (*Bassia latifolia*). Not only are the fruits of this tree used as an article of food, but the fleshy deciduous corollas are likewise largely employed for the same purpose, and, in point of fact, constitute a staple and sometimes almost the only article of diet available to the poorer classes during several months of the year. Towards the end of February or the beginning of March, as the crop of mhowa flowers approaches ripeness, the corollas, becoming fleshy and turgid with secreted juices, gradually fall to the ground in a snowy shower. The duty of collecting these is chiefly performed by women and children. Before the crop has begun to fall they take the precaution to burn away the grass and leaves at the foot of the trees, so that none of the blossoms may be hidden when they fall. The gleaners generally remain under the trees all day, alternately sleeping and collecting the crop, and the male members of the family visit the trees once or twice a day to carry away what has been collected. At night, bears, deer, and other animals visit the trees to obtain their share of the crop. In the early morning, and late in the evening, the less frequented trees, on the borders of the jungles, attract numbers of jungle and pea fowl. Cattle also are very fond of the flowers, and cow's milk has, in consequence, a strong flavor of mhowa. It often happens that the people who collect come from a considerable distance, in which case they erect with the branches of the sál a temporary encampment of huts, in which they live until the crop is all gathered in. In front of these huts a piece of ground is made quite smooth and hard, for the purpose of spreading out the flowers to dry in the sun. When perfectly dry they have a reddish-brown color, and in size they have lost three-fourths of their original dimensions and about half their original weight. It is the custom with some of the natives, before spreading them out to dry, to pull off the ring of minute foliaceous lobes which crowns the fleshy corolla. A first-class tree will continue to shed its blossoms for fifteen days, at the rate of 120 pounds a day. The rent of the trees varies with the abundance of them in the district, the quality of the previous rice harvest affecting the demand and supply. Five cents to a dollar were the extremes which Mr. Ball ascertained had been actually paid for permission to collect. As does the rent of the trees, so the saved crop varies much in price, the limits being from 120 to 480 pounds for the rupee, or fifty cents. During the famine in Manbhum the price of mhowa averaged about 24 pounds for the rupee.

Two maunds of mhowa are stated to furnish a month's food to a family consisting of a father, mother, and three children. It is, however, seldom eaten alone, being mixed with the seeds of the sál, or with the leaves of jungle plants, a small quantity of rice being sometimes added. It is the custom to cook but once a day, and each member of the family helps himself whenever he feels hungry. When fresh, the mhowa has a sweet taste, with an odor somewhat suggestive of mice; when dried, it presents some resemblance to the inferior kinds of figs. Cooking renders it vapid and utterly devoid of flavor. On distillation, the newly dried flowers yield a highly intoxicating spirit called *daru;* this is generally diluted with from five to ten times its bulk of water, and is then sold at about the rate of two cents for a quart. Its odor is most offensive to a European, but English soldiers have been known to secure for themselves the pleasures of intoxication by drinking it with held noses, as a child takes a nauseous draught. The essential oil which causes the unpleasant flavor can be got rid of by careful distillation. From the seeds a sort of oil is expressed which is used for cooking purposes.

CATTLE IN COLORADO.

THE assessors' returns of 1879 showed 523,595 cattle, and, valuing them at $12 per head, will make the total sum of $6,283,140. In 1878, 483,278 were returned, valued at $4,228,547; in 1871, there were 145,916, valued at $2,092,440; in 1875, there were 289,515 head; the increase in number between 1871 and 1878 was 337,362; increase in value, $2 332,707. These returns, the *Colorado Farmer* points out, simply show the average value of cattle on the range, and do not show them at their market value. It is estimated that the value of cattle kept for breeding and dairy purposes, together with the proper return of all, would give the money value of cattle to be not far from $7,500,000, and for the present year fully $9,000,000, owing to the immense increase by droves from Texas and Oregon.

FLORIDA ORANGE CULTURE.

BUT a few years ago there were only three kinds of oranges - the sweet, bitter sweet, and sour. Now the Florida State Association is having the fruit classified and named, so that the buyer can purchase by name as certainly as he can order Greenings or Spitzenburgs in apples. There are now about twenty-five varieties known, and nearly all named The difference in these oranges is very marked in many cases. Some are thick skinned and have a pretty center. Others are soft, heavy, and thin, but tough skinned. This is the best fruit for shipment. Some are clouded with brown and are called creoles, and, because they look bad, do not sell well in the north. Really they are the finest of the grove, and when the Floridian plucks an orange from the tree he plucks a creole. Then there is a difference as to the amount of liquid, the acidity, etc., that is becoming an important matter in orange growing.

Touching the cost of establishing an orange grove, a correspondent of the Chicago *Inter Ocean* gives the following figures on the authority of Mr. Seth French, of Jacksonville. Mr. French has planted about 100 acres of orange trees, and guarantees that the larger estimates will cover everything; and that under favorable circumstances a plantation may be started within the lower prices:

Cost of ten acres land for grove.....	$50 to	$100
Cost of clearing.....	100 to	150
Cost of fencing.....	50 to	75
Cost of breaking.....	20 to	25
Cost of setting out 500 trees	200 to	300
Cost of care and fertilizing, five years ...	500 to	1,000
Totals....	$920 to	$1,650

In addition to the above, the young trees cost, ready for setting out, about thirty-five to fifty cents each. This brings the grove to the age of nine to ten years from the seed, and it will begin to produce. At this time the average will probably be about 500 oranges to the tree. This is a delicate subject, for there are orange raisers in the State who will show trees of that age bearing 1,000 to 3,000 oranges, but 500 is, I think, a fair average. The increase is very rapid, for the next ten years especially, being perhaps 1,000 oranges per tree each year. There are old trees in the State that bear 7,500 to 10,000 oranges, but these are antebellum trees. Then it must be remembered that, like an apple crop, there are "off" years, when the yield is not up to the average. Say, however, that in ten years from the time of planting, when the trees would be about fifteen years from the seed, that the trees produce 3,000 oranges each. On an acre there are fifty trees, according to the above figures, though they usually plant sixty; at 3,000 oranges per tree there would be 1,500,000 oranges on the ten acres, which, at one and a half cents apiece as they hang on the tree, which is about the way they sell this season, would produce $22,500 off the ten acres. This is not a high estimate, and will disgust some average growers, who this year are selling $25,000 worth off six acres, but, at the low estimate, the query naturally arises, where else can so little money be invested in any business with a fortune to repay the outlay so

quickly? Then, too, the orange tree lives indefinitely. Over forty years ago they were killed by the frost, and the industry was neglected, till the people well-nigh forgot that oranges would grow in Florida. General Grant remarked that he was surprised at the rapid strides that had recently been made in the business, when he reflected it had been started by men who had come to the State with a bad liver and only one lung, because they could not live anywhere else. Now that men with two lungs and a healthy liver had taken hold of the business, it would be developed rapidly. The

PRODUCTION OF ORANGES THIS YEAR

is vastly larger than heretofore. Mr. D. H. Elliott, Secretary of the Florida Fruit-growers' Association, gave the following figures, that have been carefully gathered from the various localities: The Indian River country is producing this season 15,000 boxes, and a few more, not definitely known, are grown at Halifax and about St. Augustine. What is called the Lake Region, about Lakes Eustice, Harris, and Griffin, in Marion and Orange Counties, on the Upper Ocklawaha River, is producing 75,000 boxes. This region was a natural orange country, being covered with the wild groves that have been budded. On Orange Lake, fifty miles to the north of this region, there is being gathered 35,000 boxes. Along the Chattahoochee River about 10,000 boxes are being marketed. Along the Homossassa River, in Hernando County, about Tampa, Manatee, and other points on the Gulf coast, 100,000 boxes will cover the yield this year. On the St. John's River from Jacksonville to Enterprise and Sanford, 210 miles distant, there are being shipped 235,000 boxes. In Columbia County there are a few groves, and in Hamilton County, right at the Georgia State line, are some very fine groves, showing that the prevailing idea, like a great many notions, that the orange will not grow to perfection north of a line drawn across the State near the mouth of the St. John's, west to the Gulf, is erroneous At Pensacola there is also a crop being marketed, but of this no estimate has been made, as it is so far away from the other regions that there is no communication between them, and there is no means of knowing what the orange business is at that point from Florida sources. Taking all these points where the figures are at hand, the grand total for the season foots up to 435,000 to 450,000 boxes. In a box there are from 120 to 150 oranges.

FOREST TREES OF NORTH AMERICA.

By CHARLES S. SARGENT, Arnold Professor of Arboriculture in Harvard College, Special Agent Tenth Census.

[It is proposed to join to the Report on the Forest Wealth of the United States, now in course of preparation, a catalogue of the Forest Trees of North America, with special reference to their geographical distribution and economic properties and uses.

Knowledge of this nature in regard to our trees is still so imperfect that it is impossible to make such a catalogue at all exhaustive without the assistance of botanists and others interested in trees and their products in every part of the country.

Information on the following points is particularly needed.

1. The extreme geographical range of any species.
2. The region and elevation where any species is principally multiplied and reaches its greatest perfection.
3. The geological formation most favorable to the multiplication and development of any species.
4. Dimensions of remarkably developed specimens of any species.
5. The common or local name of any species in addition to those already given.
6. The purposes, however unimportant, for which the wood of any species is employed.
7. Products of any species other than wood, such as tannin, charcoal, dyes, potash, edible fruit, forage, etc.

To facilitate the collection and preservation of such information the present preliminary catalogue is now published.

Any information or corrections which will serve to make the final publication more exact and complete will be gratefully received and duly acknowledged.

CHARLES S. SARGENT,
Brookline, Mass]

MAGNOLIACEÆ.

1. *Magnolia acuminata*, L. (Cucumber Tree.)—Western New York to Jefferson County, Indiana; southward along the Alleghany Mountains to Georgia and Middle Tennessee. Wood soft, close-grained; preferred for pump logs. A large tree, 60 to 80 feet in height, with a trunk 2 to 4 feet in diameter.

2. *Magnolia cordata*, Michx.—Ashe County, North Carolina, along the flanks of the Alleghany Mountains to the Savannah River, and in Northern Alabama. A small or medium-sized tree.

3. *Magnolia fraseri*, Walt. *M. auriculata*, Lam. (Long-leaved Cucumber Tree.)—Along the flanks of the Alleghany Mountains, from Virginia southward to Central Alabama. "Wood soft, spongy, very light, and unfit for use."—(*Michaux f*)

4. *Magnolia glauca*, L. (Sweet Bay. White Bay.)—Essex County, Massachusetts, and from Queens County, Long Island, to Louisiana and Southern Arkansas; generally near the coast. A small tree; in swamps; the roots yielding a yellow dye.

5. *Magnolia grandiflora*, L. (Big Laurel.)—Cape Fear River, North Carolina, south to Florida; west to Texas, and ascending the Mississippi River as far as Natchez. Wood soft, easily worked, very white; probably valuable for interior work and cabinet-making. A large tree, 60 to 90 feet in height, with a trunk 2 to 3 feet in diameter.

6 *Magnolia macrophylla*, Michx. (Large-leaved Magnolia Tree.)—Iredell and Lincoln Counties, North Carolina, to Middle Florida; and west of the Alleghany Mountains, from Southeastern Kentucky southward through Tennessee to Central Alabama. A small tree, 20 to 40 feet in height, with trunk rarely exceeding one foot in diameter. Rare.

7. *Magnolia umbrella*, Lam. *M. tripetala*, L. (Umbrella Tree.)—York and Lancaster Counties, Pennsylvania, and southward along the Alleghany Mountains; throughout the Carolinas, Georgia, Northern Alabama, and westward through Kentucky and Tennessee. A small tree, rarely exceeding 40 feet in height.

8. *Liriodendron tulipifera*, L. (Tulip Tree. Yellow Poplar. White Wood.)—Bennington County, Vermont, south to Florida, and west to Eastern Kansas. Wood light, close-grained, strong, easily worked; extensively used for construction, interior work, shingles, carriage panels, etc. A large tree, 70 to 100 feet in height, with a trunk 4 to 7 feet in diameter; one of the largest and most valuable trees of the Atlantic forests.

ANONACEÆ.

9. *Anona glabra*, L. (DC. Prodr., i. 85. Coult. Bot. Gazette, iii. 2.)—Banks of the Caloosa River, and near Miami, Southern Florida (*Garber*), and in the West Indies.

10. *Asimina triloba*, Dunal. *Anona triloba*, L. *Uvaria triloba*, Torr. and Gray. (Papaw.)—Monroe County, New York, and North Erwinna, Bucks County, Pennsylvania; south to Florida; west to Fremount County, Iowa, and the Indian Territory. Wood light and spongy. A small tree, sometimes 30 feet in height, or more often a shrub; fruit sweet and edible.

GUTTIFERÆ.

11. *Clusia flava*, L.—Southern Florida, and in the West Indies.

TERNSTRŒMIACEÆ.

12. *Gordonia lasianthus*, L. (Loblolly Bay.)—Southern Virginia to Louisiana, near the coast. Wood reddish, light, brittle, close-grained, of little value. A tree 50 to 60 feet in height, with a trunk 18 to 20 inches in diameter; in swamps; bark rich in tannin.

13. *Gordonia pubescens*, L'Her.—From the Altamaha River, Georgia, near the coast, south to? A small tree, rarely exceeding 30 feet in height. Not common.

TILIACEÆ.

14. *Tilia Americana*, L. (Lime Tree. White Wood. Bass Wood.)—New Brunswick to the northern shores of Lake Superior, Southern Manitoba, and through the Northern States to Virginia; south along the Alleghany Mountains to Georgia; west to the Missouri River and Eastern Texas. Wood white, tough, pliable, easily worked; largely employed in interior work, turnery, and the manufacture of wooden ware. A tree 60 to 80 feet in height, with a trunk 3 to 4 feet in diameter; the inner bark macerated is manufactured into coarse cordage and matting. Very common in the forests of Eastern America.

Var. pubescens, Gray. *T. pubescens*, Ait.—North Carolina to Florida, near the coast. Smaller than the species; in swamps or low ground.

15. *Tilia heterophylla*, Vent. *T. alba*, Michx. f. *T. laxiflora*, Pursh. (White Bass Wood.)—Alleghany Mountains, Pennsylvania to Georgia, and westward to the valley of the lower Wabash River. A medium-sized tree, rarely exceeding 50 feet in height.

ZYGOPHYLLACEÆ.

16. *Guiacum sanctum*, L. (Lignum vitæ.)—Southern Florida, and through the West Indies. Wood exceedingly hard and heavy. A small tree.

17. *Porliera angustifolia*, Gray, Pl. Wright, i. 28. *Guiacum angustifolium*, Engelm.—outhern Texas (San Pedro River, Eagle Pass, Deadman's Hole, Pedernales River), and southward into Mexico. A small tree. "The hard and heavy yellowish-brown wood is called *Guajacum* about Saltillo, and is used as a sudorific and in venereal diseases."—Gregg.

RUTACEÆ.

18. *Xanthoxylum caribæum*, Lam. *X. Floridanum*, Nutt. (Satin Wood.)—Southern Florida. A small tree.

19. *Xanthoxylum clava-herculis*, L. *X. Carolinianum*, Lam. (Tooth-ache Tree. Prickly Ash.)—Southern Virginia to Florida, near the coast; west to Eastern Texas and Arkansas. Wood yellow, solid, close-grained. A small tree, 12 to 20 feet in height; bark, leaves, and fruit aromatic and intensely pungent, exciting salivation.

20. *Xanthoxylum pterota*, H.B.K.—Southern Florida, Southern Texas (Fort McIntosh), and southward to Brazil. Wood yellow, dense, exceedingly hard and heavy. A small tree.

SIMARUBREÆ.

21. *Simarubra glauca*, H.B.K. (Bitter Wood.)—Southern Florida, and southward through the West Indies to Brazil. A large tree.

BURSERACEÆ.

22. *Bursera gummifera*, Jacq. (West Indian Birch.)—Southern Florida, and southward through the West Indies. Wood "white, soft, brittle, and seldom put to any use but as fuel"—Nuttall. A large tree; abounding in resinous gum, soluble in alcohol and furnishing a transparent and valuable varnish.

23. *Amyris sylvatica*, Jacq. *A. Floridana*, Nutt. (Torch Wood.) Southern Florida, and southward through the West Indies. Wood "yellowish-white, close-grained, and capable of receiving a high polish."—Nuttall. A small tree; exceedingly balsamiferous.

MELIACEÆ.

24. *Swietenia mahogani*, L. (Mahogany.) Lignum Vitæ Key, east coast of Florida (Garber), Key West, and through the West Indies and Central America. Wood reddish brown, hard, heavy, very durable, and highly prized for cabinet work. A large and very valuable timber tree.

OLACINEÆ.

25. *Ximenia Americana*, L. (Mountain Plum. Hog Plum.)—Southern Florida, and southward through the West Indies. Wood yellow. A small tree; fruit an edible, plum-shaped, yellow drupe.

26. *Schœpfia arborescens*, R. & S. DC. Prodr. iv. 319. Coult. Bot. Gazette, iii. 3.—Banks of the Caloosa River, Southern Florida, and through the West Indies. A small tree.

ILICINEÆ.

27. *Ilex Dahoon*, Nutt. (Dahoon Holly.) Southeastern Virginia to Florida, and west to Louisiana near the coast. A shrub or small tree, sometimes 25 feet in height.

28. *Ilex opaca*, Ait. (American Holly.) Quincy, Massachusetts, south to Florida; west to Arkansas, Southern Missouri, and Eastern Texas; at the north only near the coast. Wood white; the heart-wood brown, close-grained, heavy; used in cabinet work, turnery, etc. A small tree, rarely 40 feet in height.

CYRILLACEÆ.

29. *Cyrilla racemiflora*, Walt. *C. Caroliniana*, Richard.—North Carolina to Florida and Alabama, near the coast. A small tree, 20 to 30 feet in height.

30. *Cliftonia Ligustrina*, Banks. *Mylocarium ligustrinum*, Willd. (Buckwheat Tree.) From the Savannah River, Georgia, south to Florida and Alabama. A shrub or sometimes a small tree, 10 to 20 feet in height; along the borders of streams and swamps in the low districts.

CELASTRACEÆ.

31. *Schæfferia frutescens*, Jacq. *S. completa*, Swartz. *S. buxifolia*, Nutt. (Crab Wood. False Box.)—Southern Florida, and in the West Indies. Wood hard and close-grained. A small tree.

(*To be continued.*)

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